


Staff Report of the
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL VALLEY REGION

The seal is circular with a double-lined border. The outer ring contains the text "STATE OF CALIFORNIA" at the top and "REGIONAL WATER QUALITY CONTROL BOARD" at the bottom, separated by two stars. The inner circle features a map of California with the Central Valley region highlighted in a darker shade. Overlaid on the map is the text "WATER QUALITY OF THE LOWER SAN JOAQUIN RIVER:", "LANDER AVENUE TO VERNALIS", "OCTOBER 1992 TO SEPTEMBER 1994", and "(WATER YEARS 1993 AND 1994)".

WATER QUALITY OF THE LOWER SAN JOAQUIN RIVER:
LANDER AVENUE TO VERNALIS
OCTOBER 1992 TO SEPTEMBER 1994
(WATER YEARS 1993 AND 1994)

JANUARY 1995

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SUMMARY

As part of our program to measure compliance with Basin Plan 5C (State Water Resources Control Board, 1989), the Agricultural Unit of the Central Valley Regional Water Quality Control Board (Regional Board) initiated a water quality monitoring program on the lower San Joaquin River in May 1985. Previous reports have been issued for data collected for Water Years (WYs) 86-92 (May 1985 through September 1992). The present report covers WYs 93 and 94 (1 October 1992 to 30 September 1994): the first above normal rainfall year after six consecutive critically dry years and the fourth driest year since 1922, respectively.

During WYs 93 and 94, selected mineral and trace element constituents were measured for total recoverable concentrations at eight monitoring sites along a 60-mile section of the San Joaquin River extending from near Stevenson at Lander Avenue to near Vernalis at Airport Way. Water quality samples were collected weekly at eight sites and analyzed for electrical conductivity (EC), boron, selenium, temperature, and pH. In addition, all samples were analyzed for chloride, sulfate, and hardness monthly. Selected sites were also analyzed for molybdenum, copper, chromium, lead, nickel, and zinc on a monthly basis.

The general trend in constituent concentrations along the San Joaquin River study area during both WY 93 and WY 94 continues to be that the lowest concentrations of measured constituents occur at the upstream ("background") and downstream (southern Delta boundary) study end points: Lander Avenue and Airport Way (Vernalis), respectively. Concentrations were highest just downstream of Lander Avenue below the Salt Slough and Mud Slough (north) confluences at Fremont Ford and Hills Ferry Road, respectively. Salt Slough and Mud Slough (north) are the two major sources of subsurface agricultural drainage to the San Joaquin River. Downstream of the Hills Ferry Road site, concentrations decreased as each of the three east side rivers provide dilution water for the San Joaquin River.

During WYs 93 and 94, calculated loads of selenium, boron, and salt in the San Joaquin River increased to levels not seen since WY 89. This pattern generally mirrored that observed in Mud Slough (north) and Salt Slough. These two sloughs accounted for 57% of the salt load, 71% of the boron load, and 86% of the selenium load in the San Joaquin River during these two WYs.

In contrast to loads, annual average selenium, boron, and salt concentrations again decreased in WY 93. Concentrations of all constituents, however, increased in WY 94, but were well below historical peak values. Dilution provided by the Merced River inflow appeared to mitigate increased concentrations seen upstream of this point; however, the mitigating effect of Merced River flows is less pronounced in critically dry years with higher loads generally corresponding to higher constituent concentrations.

In December 1988, the Regional Board adopted molybdenum, boron, and selenium water quality objectives for the San Joaquin River. These objectives and associated compliance dates were approved by the State Water Resources Control Board in September 1989, the final

month of WY 89. Compliance with objectives was to be achieved through implementation of improved irrigation management practices in order to reduce drainage flows and loads.

Molybdenum water quality objectives are delineated by location on the river: upstream of the Merced River inflow ($19 \mu\text{g/L}$) and downstream of the Merced River inflow ($10 \mu\text{g/L}$). Only one site, Lander Avenue, the single site upstream of the drainage inflows, exceeded the water quality objectives for molybdenum. The noncompliance during WY 93 was a result of natural conditions.

Boron and selenium water quality objectives are delineated by location on the river, season, and water year type. During WY 93, boron and selenium water quality objectives were in place on the lower San Joaquin River (from the mouth of the Merced River to Vernalis). During WY 94, objectives for boron and selenium were in place on the San Joaquin River from Sack Dam to the mouth of the Merced River in addition to the lower reach of the river.

As specified in the basin plan amendment adopted in December 1988, compliance monitoring for selenium and boron objectives occurs on the San Joaquin River at the Crows Landing Bridge site. The Crows Landing Bridge site is downstream of the Merced River inflow and also receives water from agricultural return flows and groundwater seepage. The water quality objective used for the river at the Crows Landing Bridge site depends on the water year type. Slightly relaxed objectives are implemented during critical water years reflecting the lack of good quality dilution flows from excess tailwater and/or flows from the eastside tributaries.

During WY 93, an above normal water year, seasonal boron objectives were exceeded in December 1992 and March and July 1993 at the Crows Landing Bridge site. WY 94, a critical water year, had a slightly relaxed boron objective of 1.3 mg/L . This mean monthly objective for boron was exceeded during two months; March and June 1994. The periods of elevated concentrations occurred during typical periods of pre-irrigation and crop irrigation.

Seasonal patterns in selenium concentration correspond with those seen for boron with peak concentrations occurring in March and then again in June or July. WY 93 showed lower overall selenium concentrations than WY 94 but still exceeded the adopted $5.0 \mu\text{g/L}$ monthly mean objective in both March and July 1993. WY 94 followed the same pattern for elevated selenium concentrations, however, since it was a critical water year, the objective for selenium was relaxed to $8 \mu\text{g/L}$. This objective was exceeded in March and June 1994.

The U.S. Environmental Protection Agency (EPA) rejected the selenium water quality objectives for the San Joaquin River upstream of the Merced River and the critical year relaxation for the San Joaquin downstream of the Merced River. In December 1992, the EPA promulgated a $5 \mu\text{g/L}$ four-day average criteria for the San Joaquin from Sack Dam to Vernalis and a $20 \mu\text{g/L}$ maximum criteria for the San Joaquin River from Sack Dam to the Merced River. These criteria apply in all water types. Data collected during this program is insufficient to calculate a four-day average concentration but a comparison can be made with the monthly mean concentration used as the Regional Board water quality objective. The more stringent federal criteria were violated at a much greater frequency than the Regional Board

objectives, especially in water year 1994, since there is no critical year relaxation. During WY 94, downstream of the Merced River inflow, the EPA selenium criteria was exceeded in 8 out of the 12 months while upstream of the Merced River inflow, it was exceeded continuously.

A review of total copper, chromium, nickel, lead, and zinc concentrations reported on a monthly basis indicated no potential water quality concerns. The conclusion was based on low overall trace element concentrations in conjunction with high hardness concentrations.

Water quality in the San Joaquin River will continue to be evaluated against objectives and milestones in upcoming water years.

INTRODUCTION

The Agricultural Unit of the Central Valley Regional Water Quality Control Board (Regional Board) initiated a water quality monitoring program on the lower San Joaquin River in May 1985. Water quality samples were collected at eight monitoring sites along a 60-mile section of the River extending from near Stevenson in Merced County to Airport Way near Vernalis in San Joaquin County (Figure 1). The purpose of this monitoring program was to compile an on-going database for selected inorganic constituents found in San Joaquin River water. This database is used to assess the effects of agricultural drainage water on the quality of the San Joaquin River. A long-term database is essential to assess the effects of the implementation of regional agricultural drainage reduction programs on overall river water quality. This report contains the results of this monitoring program for data collected from October 1992 through September 1994. This period comprises Water Year 1993 (WY 93) and Water Year 1994 (WY 94). A WY extends from 1 October of one calendar year to 30 September of the following calendar year. Reports have been issued for data collected from May 1985 through September 1992 (WYs 86-92) (James, *et al.*, 1988; Westcot, *et al.*, 1989a, 1990, 1991, and 1992, and Karkoski and Tucker, 1993). This monitoring program was designed to complement monitoring programs conducted by other state, federal, and local agencies.

STUDY AREA

The study area consists of the 60-mile section of the San Joaquin River extending from Lander Avenue (Highway 165) near Stevenson to Airport Way near Vernalis. Monitoring sites are located near each of the eight river overcrossings on this section of the River (Figure 2).

There are five major tributaries to the San Joaquin River within this study area: Salt Slough, Mud Slough (north), and the Merced, Tuolumne, and Stanislaus Rivers. Salt Slough and Mud Slough (north) drain the Grassland Area of western Merced County and discharge to the San Joaquin River in the southern portion of the study area (Figure 2). These two sloughs are the major source of agricultural subsurface drainage water discharges to the San Joaquin River. They carry a varying mixture of surface and subsurface agricultural drainage, operational spillage from irrigation canals, and seasonal drainage from duck ponds flooded each winter for waterfowl habitat. The Merced, Tuolumne, and Stanislaus Rivers are east side streams which drain the Sierra Nevada. All three streams receive some agricultural return flows in their lower reaches upstream of the San Joaquin River; however, overall water quality remains relatively high.

In addition to the five major tributaries, there are also a number of smaller tributaries, as well as surface and subsurface agricultural drains, that discharge to the San Joaquin River within the study area. The significant inflows and their locations, referenced by river mile are listed in Table 1. The monitoring sites are also listed in this table. A full description of the inflow points that occur in this 60-mile section of the river is in James, *et al.*, (1989).

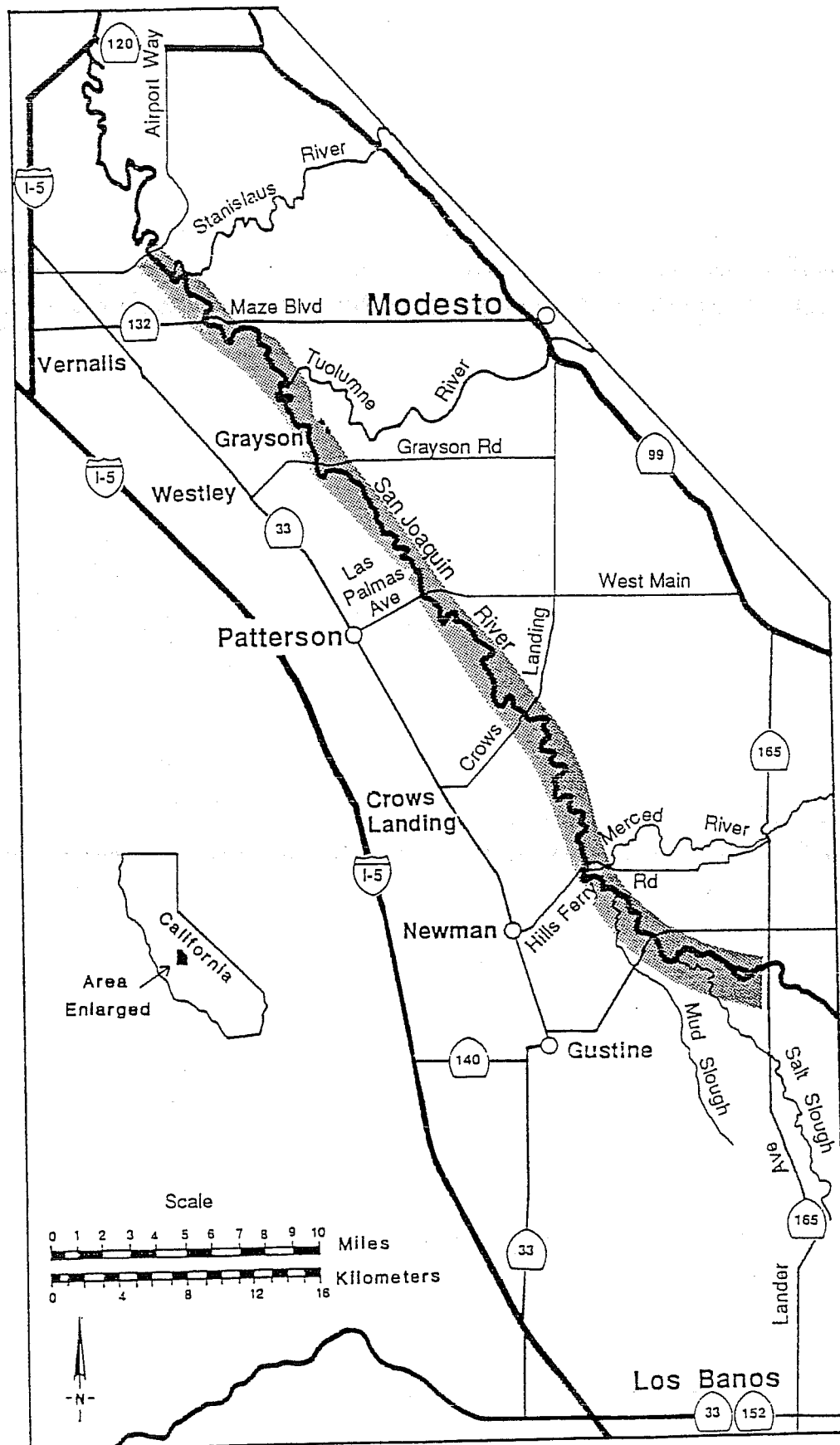


Fig. 1 Location Map

Table 1. Tributaries and Drains to the San Joaquin River Between
Monitoring Stations: Lander Avenue and Airport Way.

River Mile	Description	Water make up
132.9	Lander Avenue (Site A)	
129.7	Salt Slough	T,S
125.1	Fremont Ford (Site B)	
121.2	Mud Slough	T,S
119.6	Newman Wasteway	O,S
119.5	Newman Drainage District Collector Line A	T
119.1	Hills Ferry Road Drain	S
118.8	Hills Ferry Road (Site C)	
118.2	Merced River	N
117.5	Newman Drainage District Lateral 1	T
117.2	Azevedo Road Drain	S
113.4	Freitas Rd. Drain and South of Freitas Rd. Drain.	S
112.0	Turlock Irrigation District Lateral 6	S,O
109.0	Orestimba Creek	N,S
107.2	Crows Landing Road (Site D)	
105.0	Spanish Grant, Marshall Rd., Moran Rd. Drain	S,T
103.5	Turlock Irrigation District Lateral 5	S
100.0	Ramona Lake Main Drain	S,T
98.6	Patterson Water District Main Drain	S,T
98.4	Las Palmas Launching Facility (Site E)	
97.6	Olive Avenue Drain	S
97.3	Lemon Avenue Drain	S
97.0	Eucalyptus Avenue Drain	S
95.2	Turlock Irrigation District Lateral 3	S
92.9	Del Puerto Creek	N,S
91.4	Houk Ranch Drain	S,T
90.3	Turlock Irrigation District Lateral 4	S
89.1	Grayson Road (Site F)	
87.0	Old San Joaquin River Channel	S
83.7	Tuolumne River	N
81.1	Merced Irrigation District Lateral 4	S
79.9	Hospital/ Ingram Creeks	S,T
78.9	Center Road Drain	S
77.6	Blewett Drain	S,T
77.4	Blewett Drain	S
77.3	Maze Boulevard (Site G)	
74.9	Stanislaus River	N
73.6	Airport Way (Site H)	

LEGEND

- S Surface Agricultural Drain
- T Subsurface Agricultural Drain
- N Natural Stream
- O Operation Spillage

TEMPORAL VARIATIONS IN STREAMFLOW

A water year (WY) extends from 1 October of one year to 30 September of the following year. The Sacramento River Index, as described in the San Joaquin River Basin Plan (SWRCB, 1989) is used to classify water year type in the Sacramento and San Joaquin River Basins. WY 85 was classified as a dry water year. WY 86 was a wet year and WYs 87-92 were classified as critical water years. WY 93, presented in this report, is the first above normal water year following the six consecutive critically dry years. Major winter storms occurred in December 1992 and January 1993 with average monthly precipitation ranging from 169% to 188% of normal, respectively. The remainder of the water year followed normal precipitation patterns with the exception of an unusually dry November 1992 (17% of normal) [California Department of Water Resources, 1993]. WY 94 was classified as a critical water year. Although the WY began with generally good carry over storage in reservoirs statewide (108% of average conditions), below normal precipitation resulted in depleted supplies. The Sacramento River Index runoff for WY 94 was roughly 40% of average making it the fourth lowest runoff year since 1922 (California Department of Water Resources, 1994).

METHODS

The Regional Board monitoring program for the San Joaquin River began in May of 1985 and continued through the WY 94. Grab samples were collected on a weekly basis for seven of the eight sites during WYs 93 and 94. The eighth site, the San Joaquin River at Grayson Road, was deleted from the program after December 1992. Water temperature, pH, electrical conductivity (EC), and sample time were recorded in the field at each site. Laboratory analyses for total recoverable selenium, boron, and EC¹ were performed on all samples. On a monthly basis, samples from all sites were analyzed for chloride, sulfate and hardness, while samples from selected sites were analyzed for total recoverable molybdenum, copper, chromium, lead, nickel and zinc. Samples from the Hills Ferry Road site were also analyzed monthly for carbonate, bicarbonate, total alkalinity, calcium, potassium, sodium, total dissolved solids, and selected dissolved trace elements.

Samples were collected in polyethylene bottles. The selenium and trace element sample bottles were washed and rinsed with dilute nitric acid in the laboratory before use. All samples bottles were rinsed three times with the water to be sampled prior to sample collection.

Selenium and trace elements samples were preserved to a pH less than two with reagent grade nitric acid. Potential contamination from the acid was evaluated by submitting a ten-fold increase in the amount of acid used to control pH in a deionized water matrix and analyzed for the trace elements of concern. All reported recoveries were below the analytical detection limit. Mineral samples were kept on ice until submittal to the laboratory for analysis. A quality control and quality assurance program was conducted with blind split and spiked samples. Samples were randomly split at 10 percent of the sites with 50 percent of the splits

¹ Electrical conductivity values reported in the Appendix are laboratory EC values.

spiked for the laboratory quality assurance program. The reported results fall within the quality assurance tolerance guidelines shown in Table 2.

All samples were collected as grab samples within six feet of the river bank. As such, these samples represent a snap shot concentration at a particular location and not a continuous measurement of overall river concentration.

TABLE 2
Quality Assurance Tolerance Guidelines

Constituent	Recovery Range at Low Levels ($\mu\text{g/L}$)*	Acceptable Blind Duplicate Spike Recovery Range
Copper	1-20 +/- 5	> 20 70-130%
Chromium	1-20 +/- 5	> 20 70-130%
Lead	5-25 +/- 8	> 25 60-140%
Molybdenum	1	90-110%
Nickel	5-25 +/- 6	> 25 65-135%
Selenium	0.2	90-110%
Zinc	1-20 +/- 6	> 20 70-130%
Boron	50	85-115%
Chloride	5000	85-115%

* For certain constituents, recovery is expressed as an absolute value rather than a percentage at low levels. For example, if the result of copper analysis for a particular sample is 10 $\mu\text{g/L}$, a duplicate analysis must fall between 5 $\mu\text{g/L}$ and 15 $\mu\text{g/L}$. If the sample is greater than 20 $\mu\text{g/L}$, recovery is expressed as a percent and must be between 70 and 130%. If a recovery range is not shown at low levels, the detection limit is given.

RESULTS

The following results have been grouped by Water Year (1993 and 1994) and are presented by site in the order of the site's location on the San Joaquin River (SJR). The first site is the furthest upstream and the subsequent sites discussed are downstream from this site. The water quality objectives (WQObj) adopted for the San Joaquin River, Mud Slough (north) and Salt Slough are shown in Table 3. A summary of monthly mean selenium and boron concentrations measured on the San Joaquin River in WYs 93 and 94 are shown in Tables 4 and 5, respectively. Data below detection levels were assumed to be at one quarter of the detection level for the purpose of calculating monthly means. Tables 6 and 7 summarize annual median, maximum and minimum values for selenium, molybdenum, EC, and boron for WYs 85-94. All the data gathered during WYs 93 and 94 for each site are included in the appendix of this report.

TABLE 3

Water Quality Objectives (WQObj) as Adopted by the Central Valley Regional Board for the
San Joaquin Basin (5C)

<u>Constituent</u>	<u>Water Quality Objectives (WQObj)</u>	<u>Compliance Date</u>
San Joaquin River, mouth of the Merced River to Vernalis (Delta Inflow)		
Selenium	5 $\mu\text{g/l}$ monthly mean	12 $\mu\text{g/l}$ max. Oct. 1, 1991
	8 $\mu\text{g/l}$ monthly mean (critical year only)	Oct. 1, 1991
Molybdenum	10 $\mu\text{g/l}$ monthly mean	15 $\mu\text{g/l}$ max. Jan. 1, 1990
Boron	0.8 mg/l monthly mean (15 March-15 Sept)	2.0 mg/l max. Oct. 1, 1991
	1.0 mg/l monthly mean (16 Sept-14 March)	2.6 mg/l max. Oct. 1, 1991
	1.3 mg/l monthly mean (critical year only)	Oct. 1, 1991
Salt Slough, Mud Slough (north), San Joaquin River, Sack Dam to mouth of the Merced River		
Selenium	10 $\mu\text{g/l}$ monthly mean	26 $\mu\text{g/l}$ max. Oct. 1, 1993
Molybdenum	19 $\mu\text{g/l}$ monthly mean	50 $\mu\text{g/l}$ max. Jan. 1, 1990
Boron	2.0 mg/l monthly mean (15 March-15 Sept)	5.8 mg/l max. Oct. 1, 1993

Table 4A. Summary of WY 93 Monthly Mean Selenium Concentrations (ug/L).

Month	LOCATION: San Joaquin River at							
	Lander Ave	Freemont Ford	Hills Ferry Rd	Crows Landing	Las Palmas Ave	Maze Blvd	Grayson Rd	Airport Way
Oct-92	0.3	0.8	1.0	0.6	0.6	0.7	0.9	0.6
Nov-92	0.4	8.2	5.7	1.4	1.2	1.0	1.3	0.9
Dec-92	0.3	11	11	3.9	2.8	2.3	***	2.0
Jan-93	0.6	5.4	3.7	2.4	2.2	1.5	***	1.6
Feb-93	0.6	10	6.6	4.1	4.1	3.0	***	3.3
Mar-93	0.5	13	11	6.3	5.7	4.1	***	3.5
Apr-93	0.4	10	8.7	3.4	3.3	2.2	***	1.7
May-93	0.7	20	17	4.3	3.7	2.7	***	1.7
Jun-93	0.5	18	15	4.5	3.9	2.5	***	2.0
Jul-93	0.6	17	15	6.7	5.9	3.7	***	2.6
Aug-93	0.6	15	12	4.1	3.7	2.4	***	2.1
Sep-93	0.4	9.2	8.2	2.2	2.1	1.1	***	1.0
WQ Obj*	10 µg/L				5 µg/L			

*Water quality objectives for above normal runoff year.

***No samples taken.

Bold numbers indicate exceedance of the current or future adopted monthly mean water quality objectives.

Table 4B. Summary of WY 94 Monthly Mean Selenium Concentrations (ug/L).

Month	LOCATION: San Joaquin River at							
	Lander Ave	Freemont Ford	Hills Ferry Rd	Crows Landing	Las Palmas Ave	Maze Blvd	Grayson Rd	Airport Way
Oct-93	0.2	3.0	2.0	1.0	0.7	0.8	***	0.8
Nov-93	0.5	7.0	5.5	2.9	2.6	1.6	***	1.6
Dec-93	0.2	8.1	5.9	3.8	3.5	2.1	***	2.0
Jan-94	1.0	13	7.3	4.0	3.9	2.2	***	1.7
Feb-94	0.4	13	8.3	5.5	5.6	3.4	***	2.9
Mar-94	0.7	21	16	9.2	8.4	6.0	***	4.3
Apr-94	0.4	21	17	7.1	6.5	3.7	***	2.6
May-94	1.0	23	18	7.0	6.3	3.9	***	2.6
Jun-94	0.9	26	23	11	8.1	4.5	***	2.9
Jul-94	0.6	26	22	8.7	8.2	5.2	***	3.5
Aug-94	0.4	21	15	7.7	6.9	4.0	***	2.7
Sep-94	0.7	20	12	6.0	4.0	2.8	***	2.3
WQ Obj*	10 µg/L				8 µg/L			

*Water quality objectives for critical runoff year.

***No samples taken.

Bold numbers indicate exceedance of the current or future adopted monthly mean water quality objectives.

Table 5A. Summary of WY 93 Monthly Mean Boron Concentrations (mg/L).

Month	LOCATION: San Joaquin River at							
	Lander Ave	Freemont Ford	Hills Ferry Rd	Crows Landing	Las Palmas Ave	Maze Blvd	Grayson Rd	Airport Way
Oct-92	1.0	0.84	0.94	0.50	0.47	0.40	0.5	0.27
Nov-92	1.0	2.0	1.8	0.50	0.53	0.40	0.5	0.37
Dec-92	0.94	2.3	2.5	1.2	0.86	0.70	***	0.59
Jan-93	0.05	0.76	0.84	0.50	0.51	0.40	***	0.36
Feb-93	0.08	1.6	1.4	0.83	0.89	0.60	***	0.56
Mar-93	0.12	1.7	1.9	1.1	1.1	0.79	***	0.67
Apr-93	0.11	1.4	1.4	0.60	0.61	0.40	***	0.35
May-93	0.30	2.4	2.3	0.70	0.63	0.50	***	0.27
Jun-93	0.21	2.6	2.3	0.78	0.70	0.50	***	0.35
Jul-93	0.29	2.2	2.1	0.96	0.88	0.70	***	0.50
Aug-93	0.34	2.1	1.8	0.65	0.63	0.50	***	0.38
Sep-93	0.32	1.3	1.5	0.40	0.37	0.22	***	0.21
WQ Obj*	2.0 mg/L (15 Mar-15 Sep) ————— 0.8 mg/L (15 Mar-15 Sep) and 1.0 mg/L (16 Sep-14 Mar)							

*Water quality objectives for above normal runoff year.

*** No Samples taken.

Bold numbers indicate exceedance of the current or future adopted monthly mean water quality objectives.

Table 5B. Summary of WY 94 Monthly Mean Boron Concentrations (mg/L).

Month	LOCATION: San Joaquin River at							
	Lander Ave	Freemont Ford	Hills Ferry Rd	Crows Landing	Las Palmas Ave	Maze Blvd	Grayson Rd	Airport Way
Oct-93	0.26	1.0	0.81	0.33	0.27	0.22	***	0.17
Nov-93	0.13	1.3	1.3	0.72	0.76	0.50	***	0.42
Dec-93	0.21	1.7	1.5	0.93	0.94	0.59	***	0.50
Jan-94	0.36	2.3	1.8	1.1	1.1	0.59	***	0.54
Feb-94	0.11	1.7	1.5	1.0	0.92	0.63	***	0.59
Mar-94	0.24	2.4	2.3	1.4	1.3	0.93	***	0.69
Apr-94	0.28	2.5	2.3	1.1	1.0	0.58	***	0.46
May-94	0.27	2.5	2.3	1.0	0.83	0.50	***	0.35
Jun-94	0.32	3.3	3.5	1.5	1.3	0.83	***	0.53
Jul-94	0.36	2.6	2.0	1.0	1.0	0.75	***	0.46
Aug-94	0.42	2.4	1.9	1.2	1.1	0.76	***	0.49
Sep-94	0.37	2.0	1.6	1.0	0.70	0.52	***	0.44
WQ Obj*	2.0 mg/L (15 Mar-15 Sep) ————— 1.3 mg/L							

*Water quality objectives for critical runoff year.

*** No Samples taken.

Bold numbers indicate exceedance of the current or future adopted monthly mean water quality objectives.

Table 6. Ranges of Selenium and Molybdenum Concentration by Water Year (WY) for Monitoring Sites Along the Lower San Joaquin River. (Data taken from James, et al. 1988, Westcot, et al. 1989, 1990, 1991 and 1992, and Karkoski and Tucker, 1993)

WATER YEAR/TYPE		AIRPORT WAY	MAZE BLVD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
WY 1985 DRY									
	Minimum	1	1	1	<1	1	1	<1	<1
Se	Median	1	2	2	3	3	4	4	<1
(µg/L)	Maximum	2	3	3	4	4	8	7	1
	# Samples	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(5)
WY 1986 WET									
	Minimum	0.6 (<1)	0.8 (<1)	0.9 (<1)	<1	<1	<1	<1	0.2 (<1)
Se	Median	1	1.5	2.2	2	2	4	1.7	0.3
(µg/L)	Maximum	4	2.4	4	5	4	8	9	5
	# Samples	(19)	(19)	(16)	(18)	(19)	(19)	(19)	(19)
	Minimum	0.6 (<1)	<1	<1	<1	<1	2.6 (<5)	2.9 (<5)	<1
Mo	Median		<5	<5	<5	<5	5.1	<5	<5
(µg/L)	Maximum	1.6 (<5)	8	13	12	14	14	17	5
	# Samples	(16)	(15)	(12)	(17)	(14)	(16)	(16)	(15)
WY 1987 CRITICAL									
	Minimum	0.9	1.4	3.4	3.4	3.6	6.6	4.3	0.4
Se	Median	2.3	3.3	4.6	4.8	5.6	11	10	0.7
(µg/L)	Maximum	3.2	5.8	9.3	10	12	21	26	1.8
	# Samples	(15)	(11)	(11)	(11)	(15)	(15)	(14)	(15)
	Minimum	1 (<5)				4 (<5)	<5		4 (<5)
Mo	Median	2 (<5)				4	7		7
(µg/L)	Maximum	2 (<5)				5	12		14
	# Samples	(11)				(10)	(11)		(10)
WY 1988 CRITICAL									
	Minimum	0.8	1.9	2.4	2.0	0.8	1.0	1.3	0.2
Se	Median	2.7	5.1	5.8	6.2	7.4	10	12	0.7
(µg/L)	Maximum	6.5	6.5	8.5	9.1	12	20	23	1.4
	# Samples	(41)	(13)	(12)	(14)	(42)	(41)	(40)	(38)
	Minimum	2				3	4		3
Mo	Median	3				5	6		15
(µg/L)	Maximum	4				7	11		22
	# Samples	(6)				(35)	(30)		(35)
WY 1989 CRITICAL									
	Minimum	1.4	3.2	3.5	3.0	3.4	2.8	3.4	0.3
Se	Median	2.9	4.4	5.8	6.0	6.9	9.8	12	0.5
(µg/L)	Maximum	6.8	8.0	12	14	17	23	32	1.3
	# Samples	(46)	(14)	(13)	(13)	(47)	(46)	(47)	(46)
	Minimum	1				2	3		1
Mo	Median	2				4	6		16
(µg/L)	Maximum	5				7	11		30
	# Samples	(44)				(46)	(46)		(47)
WY 1990 CRITICAL									
	Minimum	0.8	1.7	2.9	1.7	1.6	2.7	4.4	<0.2
Se	Median	2.4	4.0	5.0	4.6	7.2	11	14	0.4
(µg/L)	Maximum	9.6	9.8	10	10	13	26	33	1.7
	# Samples	(49)	(35)	(12)	(12)	(49)	(49)	(49)	(49)
	Minimum	1	1			2	3	4	3
Mo	Median	2	4			5	8	8	20
(µg/L)	Maximum	5	6			8	18	14	59
	# Samples	(46)	(20)			(48)	(48)	(26)	(48)

Table 6 continued:

WATER YEAR/TYPE	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
WY 1991 CRITICAL								
Minimum	0.5	0.8	1.0	0.6	0.7	1.0	0.9	0.2
Se Median	1.9	2.7	4.3	4.9	6.1	9.5	13	0.4
(µg/L) Maximum	4.8	5.6	7.3	8.3	11	24	30	0.8
# Samples	(54)	(54)	(38)	(38)	(53)	(53)	(52)	(52)
Minimum	1				0.6	1	1	0.3
Mo Median	2				6	12	12	22
(µg/L) Maximum	4				9	19	35	74
# Samples	(45)				(42)	(44)	(36)	(43)
WY 1992 CRITICAL								
Minimum	0.4	0.4	0.6	0.5	0.5	1.0	0.8	0.1
Se Median	1.5	2.1	3.3	3.2	4.6	8.6	11	0.3
(µg/L) Maximum	4.4	5.4	7.2	8.2	11	19	25	0.6
# Samples	(57)	(57)	(53)	(54)	(57)	(58)	(58)	(48)
Minimum	1				3	5	7	6
Mo Median	2				5	10	11	34
(µg/L) Maximum	5				10	15	15	50
# Samples	(9)				(17)	(10)	(9)	(17)
WY 1993 ABOVE NORMAL								
Minimum	0.20	0.50	0.30	0.20	0.20	0.60	0.60	0.10
Se Median	1.9	2.3	1	3.5	3.8	11	13	0.50
(µg/L) Maximum	6.1	4.9	1.3	6.7	8.5	23	29	1.3
# Samples	(50)	(50)	(6)	(50)	(50)	(50)	(50)	(50)
Minimum	1				2	2	6	2
Mo Median	2				3	10	10	11
(µg/L) Maximum	3				8	18	14	55
# Samples	(11)				(11)	(12)	(9)	(11)
WY 1994 CRITICAL								
Minimum	0.4	0.2		0.2	0.3	1.2	1.2	<0.2
Se Median	2.6	3.6		5.1	6.1	13	19	0.5
(µg/L) Maximum	6.3	7.0		14	13	28	35	1.8
# Samples	(50)	(51)		(51)	(52)	(52)	(52)	(52)
Minimum	1				1	2	2	1
Mo Median	2				5	9	8	10
(µg/L) Maximum	3				15	19	13	17
# Samples	(10)				(11)	(11)	(9)	(10)

Table 7. Ranges of Electrical Conductivity and Boron Concentration by Water Year (WY) for Monitoring Sites Along the Lower San Joaquin River. (Data from James, et al. 1988, Westcot, et al. 1989, 1990, 1991 and 1992, and Karkoski and Tucker 1993.)

WATER YEAR/TYPE	AIRPORT WAY	MAZE BLVD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
WY 1985 DRY								
EC Minimum	480	620	690	640	630	730	640	192
EC Median	540	860	1000	1050	995	1325	1150	700
EC Maximum	680	900	1050	1200	1200	2200	1900	1300
# Samples	(6)	(6)	(5)	(6)	(6)	(6)	(6)	(5)
B Minimum	0.20	0.25	0.38	0.26	0.27	0.45	0.33	<0.01
B Median	0.27	0.43	0.48	0.62	0.64	1.1	0.93	0.10
B Maximum	0.45	0.60	0.78	0.86	0.85	1.6	1.2	0.36
# Samples	(6)	(6)	(5)	(6)	(6)	(6)	(6)	(5)
WY 1986 WET								
EC Minimum	180	200	280	240	270	410	94	73
EC Median	540	700	960	870	815	1100	905	400
EC Maximum	980	1100	1700	1800	1700	2600	2300	930
# Samples	(18)	(17)	(15)	(18)	(18)	(18)	(18)	(18)
B Minimum	0.10	0.13	0.17	0.11	0.14	0.29	0.09	<0.01
B Median	0.22	0.39	0.57	0.56	0.59	0.91	0.65	0.10
B Maximum	0.7	0.70	1.2	1.7	1.2	2.2	1.8	0.61
# Samples	(17)	(17)	(15)	(18)	(18)	(18)	(18)	(18)
WY 1987 CRITICAL								
EC Minimum	340	490	1200	1200	1200	1600	1330	650
EC Median	804	1100	1300	1360	1320	1720	1730	1200
EC Maximum	930	1420	1890	1960	1990	2600	2880	1650
# Samples	(13)	(9)	(9)	(9)	(13)	(10)	(12)	(13)
B Minimum	0.18	0.30	0.59	0.70	0.67	0.53	0.81	0.10
B Median	0.43	0.64	0.88	0.95	0.94	1.6	1.6	0.21
B Maximum	0.62	1.1	1.6	1.8	1.9	3.0	3.2	0.35
# Samples	(15)	(11)	(11)	(11)	(15)	(13)	(14)	(15)
WY 1988 CRITICAL								
EC Minimum	650	1010	1300	750	1180	1380	1260	320
EC Median	900	1400	1580	1600	1600	1990	1950	1550
EC Maximum	1450	1600	1950	2150	2150	3100	2950	2100
# Samples	(43)	(13)	(12)	(14)	(43)	(41)	(42)	(40)
B Minimum	0.28	0.50	0.66	0.48	0.46	0.57	0.41	0.03
B Median	0.50	0.90	1.0	1.2	1.2	1.7	1.8	0.30
B Maximum	0.95	1.1	1.5	3	2	3.1	2.8	0.47
# Samples	(43)	(13)	(12)	(14)	(43)	(41)	(42)	(40)
WY 1989 CRITICAL								
EC Minimum	720	880	1160	1220	1000	1360	1300	380
EC Median	980	1290	1480	1490	1520	1930	2010	1500
EC Maximum	1510	1740	2100	2220	2210	3350	3300	1990
# Samples	(46)	(14)	(13)	(13)	(47)	(46)	(47)	(47)
B Minimum	0.37	0.60	0.64	0.76	0.68	0.69	0.67	0.06
B Median	0.54	0.80	0.9	1.0	1.2	1.7	1.8	0.32
B Maximum	1.0	1.2	1.6	1.8	1.9	3.0	3.3	0.54
# Samples	(45)	(14)	(13)	(13)	(46)	(46)	(46)	(46)
WY 1990 CRITICAL								
EC Minimum	600	930	1250	1060	1180	1120	1180	440
EC Median	920	1340	1430	1530	1710	2490	2400	1500
EC Maximum	1380	1640	1900	2160	2030	4120	3070	2940
# Samples	(49)	(35)	(12)	(12)	(49)	(46)	(49)	(48)
B Minimum	0.31	0.55	0.66	0.67	0.67	0.88	0.82	0.09
B Median	0.50	0.79	0.91	1.1	1.2	2.1	2.0	0.33
B Maximum	1.1	1.2	1.2	1.5	1.7	3.2	3.3	0.69
# Samples	(49)	(35)	(12)	(12)	(49)	(48)	(49)	(49)

Table 7.(continued):

WATER YEAR/TYPE	AIRPORT WAY	MAZE BOULEVARD	GRAYSON ROAD	LAS PALMAS AVENUE	CROWS LANDING	HILLS FERRY	FREMONT FORD	LANDER AVENUE
WY 1991 CRITICAL								
Minimum	410	530	600	560	560	750	600	150
EC Median	990	1280	1670	1740	1720	2620	2620	2240
(µmhos/cm) Maximum	1680	1750	2310	2450	2490	4360	4290	3420
# Samples	(54)	(54)	(38)	(38)	(53)	(53)	(52)	(52)
Minimum	0.20	0.28	0.31	0.28	0.30	0.46	0.37	0.08
B Median	0.46	0.64	0.92	1.0	1.1	1.9	2.0	0.43
(mg/L) Maximum	1.2	1.3	1.7	1.9	2.1	3.4	4.4	0.75
# Samples	(54)	(54)	(38)	(38)	(53)	(53)	(52)	(52)
WY 1992 CRITICAL								
Minimum	389	410	895	880	670	880	820	100
EC Median	925	1260	1530	1570	1570	2630	2670	2200
(µmhos/cm) Maximum	1450	1540	1950	2060	2180	3620	3800	3990
# Samples	(58)	(58)	(53)	(54)	(58)	(58)	(58)	(53)
Minimum	0.16	0.20	0.25	0.24	0.23	0.34	0.28	0.038
B Median	0.44	0.61	0.74	0.86	1.0	1.9	1.9	0.46
(mg/L) Maximum	0.93	1.1	1.4	1.5	1.8	3.2	4.9	0.98
# Samples	(58)	(58)	(53)	(53)	(57)	(56)	(57)	(52)
WY 1993 ABOVE NORMAL								
Minimum	360	380	690	410	330	430	210	130
EC Median	708	881	1400	1090	980	2250	2120	1230
(µmhos/cm) Maximum	1420	1620	1580	2000	1940	3650	3710	4060
# Samples	(50)	(50)	(6)	(50)	(50)	(50)	(50)	(50)
Minimum	0.01	0.17	0.23	0.21	0.17	0.27	0.1	0.04
B Median	0.38	0.48	0.50	0.67	0.66	1.8	1.7	0.28
(mg/L) Maximum	0.83	0.92	1.3	1.3	2.1	3.0	3.5	1.1
# Samples	(50)	(50)	(6)	(50)	(50)	(50)	(50)	(50)
WY 1994 CRITICAL								
Minimum	217	211		249	209	1030	1110	204
EC Median	845	1040		1450	1440	2280	2430	1190
(µmhos/cm) Maximum	1270	1510		2030	2040	3670	3590	1950
# Samples	(50)	(51)		(51)	(52)	(52)	(52)	(51)
Minimum	0.07	0.08		0.11	0.11	0.61	0.67	<0.05
B Median	0.49	0.64		0.97	1.1	1.9	2.1	0.29
(mg/L) Maximum	0.95	1.0		1.8	1.9	5.0	4.0	0.65
# Samples	(49)	(51)		(51)	(52)	(52)	(52)	"(52)

Water Year 1993

The site furthest upstream on the San Joaquin River was at Lander Avenue. During WY 93, the water at this site contained low concentrations of selenium (median concentration $0.5 \mu\text{g/L}$) and boron (median concentration 0.28 mg/L). In contrast to the relatively low concentrations of boron and selenium, this site had the highest median concentration of molybdenum at $11 \mu\text{g/L}$. The adopted monthly mean molybdenum objective ($19 \mu\text{g/L}$) and maximum adopted objective ($50 \mu\text{g/L}$) were exceeded in October, November, and December 1992, with concentrations of 51, 55, and $51 \mu\text{g/L}$, respectively. Molybdenum concentrations at the site were below $16 \mu\text{g/L}$ for the remainder of WY 93². All other San Joaquin River sites downstream of Lander Avenue consistently met the adopted molybdenum water quality objectives.

The next downstream site sampled on the San Joaquin River was at Fremont Ford, which is downstream of the confluence with Salt Slough. Salt Slough carries a combination of agricultural surface and subsurface drainage, storm runoff from surrounding lands and the city of Los Banos, and seasonal releases from duck clubs. With the exception of temperature, pH, and molybdenum concentrations, all constituents at the Fremont Ford site were elevated over the concentrations reported upstream at Lander Avenue during WY 93. In particular, median EC, boron and selenium values were reported at $2120 \mu\text{mhos/cm}$, 1.7 mg/L and $13 \mu\text{g/L}$, respectively. In WY 93, this site frequently exceeded the monthly mean WQObjs for boron (2.0 mg/L) and selenium ($10 \mu\text{g/L}$) that are planned for implementation in WY 94 (shown below).

<u>Month</u>	<u>Boron (mg/L)</u>	<u>Selenium ($\mu\text{g/L}$)</u>
Dec.	---	11
Mar.	---	13
May	2.4	20
Jun.	2.6	18
Jul.	2.2	17
Aug.	2.1	16

The maximum WQObj for boron of 5.8 mg/L (scheduled for implementation in WY 94) was not exceeded at this site during WY 93. The highest concentrations of boron found in the river at Fremont Ford was 3.5 mg/L . The maximum WQObj for selenium of $26 \mu\text{g/L}$ (scheduled for implementation in WY 94) was exceeded once on 14 May 1993, at $29 \mu\text{g/L}$. All other selenium concentrations were below $23 \mu\text{g/L}$ with a median concentration of $13 \mu\text{g/L}$.

The next downstream sampling site on the San Joaquin River was near Hills Ferry Road, just downstream of the confluence of Mud Slough (north) but upstream of the Merced River

²Only one sample per month was analyzed for molybdenum during this period.

inflow. Mud Slough (north), as with Salt Slough, carries agricultural return flows, storm water, and wetland releases. Drainage flows can readily be switched between the two sloughs through a series of diversion structures so that either slough is able to carry runoff from the other's watershed. During WY 93, the Hills Ferry Road site had the highest median concentration for all the trace elements measured except molybdenum. Median concentrations for boron and selenium were 1.8 mg/L and 11 $\mu\text{g/L}$, respectively. EC concentration reached 3,650 $\mu\text{mhos/cm}$ with a median of 2,250 $\mu\text{mhos/cm}$. The monthly mean WQObjs for both selenium and boron (scheduled for implementation in WY 94) were exceeded at Hills Ferry Road site several times during WY 93 (shown below).

<u>Month</u>	<u>Boron (mg/L)</u>	<u>Selenium ($\mu\text{g/L}$)</u>
Dec.	---	11
Mar.	---	11
May	2.3	17
Jun.	2.3	15
Jul.	2.1	15
Aug.	---	12

The maximum WQObjs for selenium and boron (scheduled for implementation in WY 94) were never exceeded at this location during WY 93. The maximum concentrations found for selenium and boron at this site were 23 $\mu\text{g/L}$ and 3.0 mg/L, respectively.

The San Joaquin River segment downstream of the Merced River confluence (downstream of the Hills Ferry Road site) has different adopted water quality objectives than the section of river upstream of the confluence. The adopted WQObjs for this river reach are given in Table 3. Since WY 93 was classified as an above normal water year, the critical year WQObjs shown in Table 3 do not apply.

The monthly mean WQObj for selenium (5.0 $\mu\text{g/L}$) was exceeded at the Crows Landing Bridge site in both March and July during WY 93 with concentrations of 6.3 $\mu\text{g/L}$ and 6.7 $\mu\text{g/L}$, respectively. The maximum WQObj for selenium (12 $\mu\text{g/L}$) was not exceeded during WY 93.

The monthly mean boron objective of 1.0 mg/L which applies between 16 Sept-14 March, was exceeded at the Crows Landing Bridge site in December and March (1.2 mg/L and 1.1 mg/L, respectively) during WY 93. The monthly mean boron objective of 0.8 mg/L which applies between 15 March-15 Sept, was exceeded during July (0.96 mg/L). The maximum boron WQObjs of 2.6 mg/L between 16 Sept-14 March and 2.0 mg/L between 15 March-15 Sept, were not exceeded during WY 93.

The sampling sites downstream of Crows Landing Bridge had decreasing concentrations of all constituents, with the lowest median values of boron (0.38 mg/L) and EC (708 $\mu\text{mhos/cm}$) found at the downstream end of the study area (San Joaquin River at Airport Way). The monthly mean boron and selenium WQObjs were both exceeded twice downstream of Crows

Landing Bridge. These two exceedances occurred at the Las Palmas (Patterson) site during March and July 1993. Mean selenium values for March and July were 5.7 $\mu\text{g/L}$ and 5.9 $\mu\text{g/L}$, respectively, while boron was 1.1 and 0.88 mg/L, respectively. These exceedances corresponded to the same time period of exceedances at the upstream Crows Landing Bridge site. Maximum WQObjs were not exceeded at any site downstream of the Crows Landing Bridge.

Water Year 1994

After a brief respite from a six-year drought with above normal runoff in WY 93, the valley returned to a dry weather pattern in WY 94. Runoff during WY 94, was approximately 40% of average and the fourth lowest on record (since 1922). WY 94 was listed as a critical water year by the California Department of Water Resources (DWR, 1994). WY 94 was also the first year that all adopted WQObjs for boron and selenium went into effect on the San Joaquin River between Sack Dam and the mouth of the Merced River (upstream of the Merced River inflow).

Mean monthly selenium and boron concentrations in the San Joaquin River at Lander Avenue, during WY 94, were comparable to those reported for WY 93 (Tables 4B and 5B, respectively). During WY 94, median selenium and boron concentrations were 0.5 $\mu\text{g/L}$ and 0.29 mg/L, respectively, at this site. Molybdenum concentrations continue to remain elevated with a median concentration of 10 $\mu\text{g/L}$. However, in contrast to WY 93, the adopted WQObj for molybdenum (19 $\mu\text{g/L}$) was not exceeded during WY 94. The maximum molybdenum concentration reported was 17 $\mu\text{g/L}$ and occurred near the end of September 1994.

Constituent concentrations downstream at the Fremont Ford site were elevated over those reported at Lander Avenue with the exception of molybdenum, a trend similar to WY 93. The increases in EC, boron and selenium reflect the inflows from Salt Slough upstream of the sampling location. Median EC, boron, and selenium concentrations for WY 94 were 2,430 $\mu\text{mhos/cm}$, 2.1 mg/L, and 19 $\mu\text{g/L}$, respectively. The mean monthly WQObjs for boron (2.0 mg/L from 15 March through 15 September) and selenium (10 $\mu\text{g/L}$) were exceeded almost continuously during WY 94, as indicated below.

<u>Month</u>	<u>Boron (mg/L)</u>	<u>Selenium ($\mu\text{g/L}$)</u>
Jan	---	13
Feb	---	13
Mar	2.4	21
Apr	2.5	21
May	2.5	23
Jun	3.3	26
Jul	2.6	26
Aug	2.4	21
Sept	2.0	20

Although the maximum WQObj for boron (5.8 mg/L) was not exceeded at this site during WY 94, the maximum selenium WQObj (26 $\mu\text{g/L}$) was. On seven separate occasions between May 1994 and August 1994, selenium concentrations in the River at Fremont Ford exceeded 26 $\mu\text{g/L}$. The maximum measured selenium concentration was 35 $\mu\text{g/L}$ and occurred on 13 July 1994.

The San Joaquin River at Hills Ferry Road receives inflow from Mud Slough (north) in addition to Salt Slough. During WY 94, average flow in Mud Slough (north) was low with the majority of subsurface agricultural drainage being diverted to Salt Slough; however, concentrations of salt and boron in Mud Slough (north) remained elevated over downstream river concentrations reflecting the nature of the local ground water quality (Vargas, et al, 1995). Median concentrations for boron and selenium at the Hills Ferry Road site were 1.9 mg/L and 13 $\mu\text{g/L}$, respectively. EC concentrations ranged from 1,030 to 3,670 $\mu\text{mhos/cm}$ with a median of 2,280 mhos/cm. Monthly mean WQObjs for both boron and selenium were exceeded several times at the Hills Ferry Road site during WY 94 (shown below).

<u>Month</u>	<u>Boron (mg/L)</u>	<u>Selenium ($\mu\text{g/L}$)</u>
Mar	2.3	16
Apr	2.3	17
May	2.3	18
Jun	3.5	23
Jul	---	22
Aug	---	15
Sept	---	12

The maximum WQObj for boron (5.8 mg/L) was not exceeded at this site. The maximum selenium WQObj (26 $\mu\text{g/L}$) was exceeded on three separate occasions with concentrations reaching 28, 27, and 27 $\mu\text{g/L}$ on 16 May, 21 June, and 13 July 1994, respectively.

Below the Merced River inflow, monthly mean WQObjs change for the downstream segment of the San Joaquin River (Table 3). During WY 94, a critical water year, the adopted selenium WQObj is 8 $\mu\text{g/L}$ with a maximum of 12 $\mu\text{g/L}$. The boron WQObj is 1.3 mg/L with no specified maximum.

The monthly mean selenium WQObj (8 $\mu\text{g/L}$) was exceeded at the Crows Landing Bridge site during March, June, and July in WY 94 with concentrations of 9.2 $\mu\text{g/L}$, 11 $\mu\text{g/L}$ and 8.7 $\mu\text{g/L}$, respectively. The maximum selenium WQObj (12 $\mu\text{g/L}$) was exceeded on 21 June, 29 June, and 13 July 1994 with all three concentrations at 13 $\mu\text{g/L}$.

The mean monthly boron WQObj (1.3 mg/L) was exceeded at the Crows Landing Bridge site twice during WY 94. The first exceedance (1.4 mg/L) occurred in March and the second (1.5 mg/L) in June. The median boron concentration for WY 94, was 1.1 mg/L.

Downstream of the Crows Landing Bridge site, the San Joaquin River receives inflow from two additional east side tributaries: the Tuolumne and Stanislaus Rivers. Salt, boron and selenium concentrations are very low in these tributaries and improve the water quality in the San Joaquin River accordingly. The Las Palmas site is just upstream of these tributary inflows and concentrations at this site corresponded to those measured at the Crows Landing Bridge site. At the Las Palmas site, the selenium WQObj ($8 \mu\text{g/L}$) was exceeded three times with concentrations reported at 8.4, 8.1, and $8.2 \mu\text{g/L}$ during March, June, and July, respectively. The mean monthly boron WQObj (1.3 mg/L) was not exceeded at the Las Palmas site during WY 94.

Monitoring sites downstream of the Las Palmas site showed decreasing constituent concentrations. At the farthest downstream sampling location, the San Joaquin River at Airport Way, median boron and selenium concentrations were 0.49 mg/L and $2.6 \mu\text{g/L}$, respectively. EC ranged from 217 to $1,270 \mu\text{mhos/cm}$ with a median of $845 \mu\text{mhos/cm}$. None of the adopted mean monthly WQObjs listed in Table 3 were exceeded at monitoring sites downstream of the Las Palmas site during WY 94.

DISCUSSION

Boron and Selenium

Karkoski and Tucker (1993) showed that significant selenium and boron load reductions to the San Joaquin River from the Grassland Area occurred between WY 87 and WY 92. These load reductions were credited with the less severe and less frequent exceedance of water quality objectives in the San Joaquin River. The most significant reductions occurred during six consecutive critically dry years, WY 87 through WY 92.

WY 93 was the first above normal rainfall year after six critical water years. Although WY 93 began with an unusually dry November in 1992 (17% of normal), major winter storms followed in December 1992 and January 1993. Average monthly precipitation during December and January were 169 and 188% of normal, respectively. The remainder of the water year followed normal precipitation patterns (DWR, 1993). WY 94 marked the return of the valley to critically dry conditions. Runoff was approximately 40% of average with WY 94 having the fourth lowest runoff volume on record (since 1922) [DWR, 1994]. WY 94 also marked the first year that adopted WQObjs for selenium and boron were in place on the San Joaquin River between Sack Dam and the mouth of the Merced River.

Figures 3 and 4 compare median boron and selenium concentrations, respectively for the Hills Ferry Road and Crows Landing Bridge sites from WY 87 through WY 94. Concentrations for both elements are higher at the Hills Ferry Road site as compared to the Crows Landing Bridge site. The San Joaquin River at the Hills Ferry Road monitoring site is dominated by flows from Mud Slough (north) and Salt Slough and reflects the quality of water flowing through those channels. Between Hills Ferry Road and the Crows Landing Bridge, the river receives inflows from a number of drains and operational spills as well as the Merced River

Figure 3. Annual Median Boron Values for Crows Landing Bridge and Hills Ferry Road Monitoring Sites: WYs 86-94

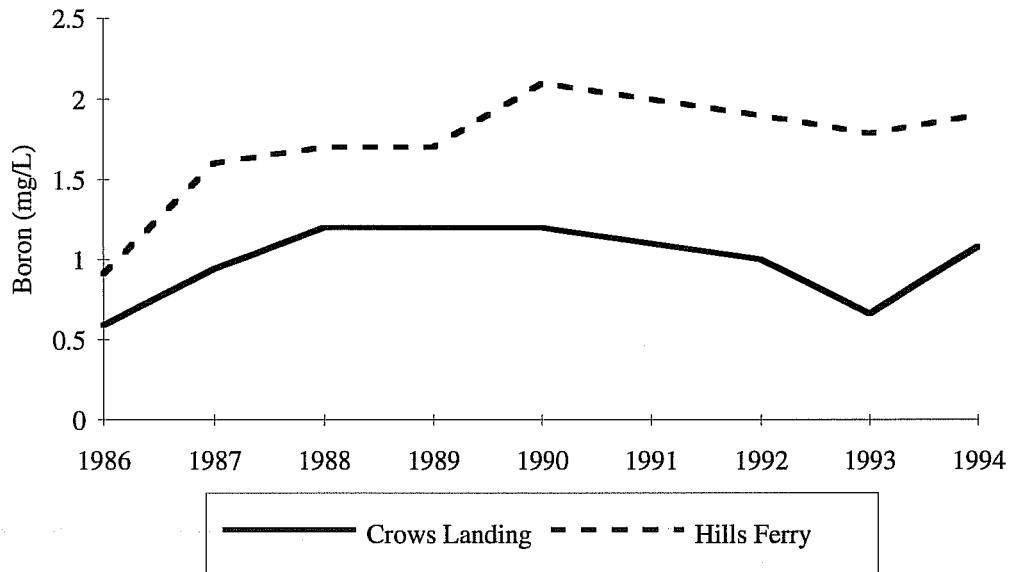
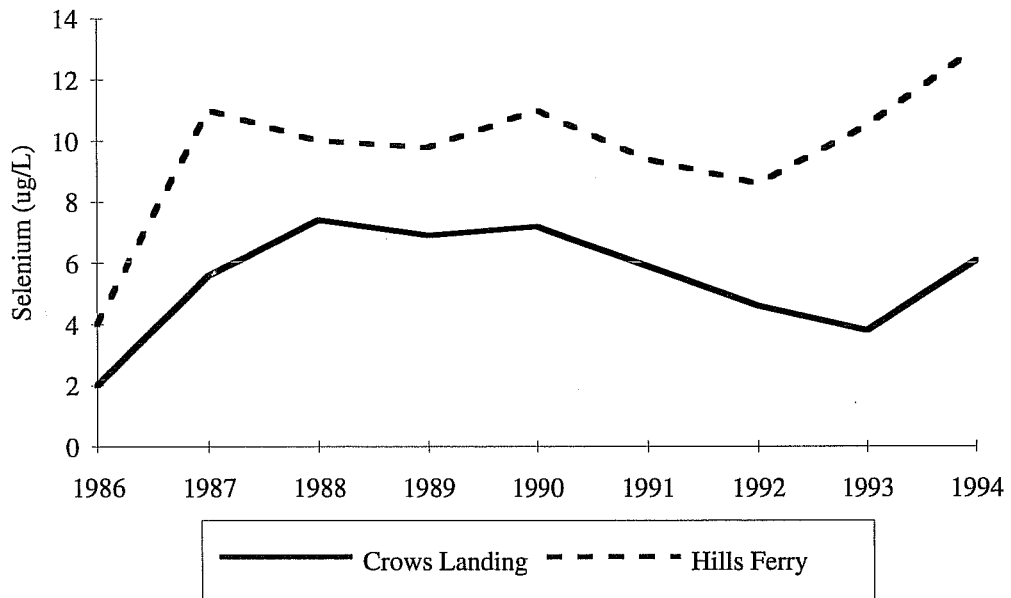


Figure 4. Annual Median Selenium Values for Crows Landing Bridge and Hills Ferry Road Monitoring Sites: WYs 86-94.



(refer to Table 1). Although these inflows contain agricultural discharges, the overall boron and selenium concentrations are lower than those from Mud Slough (north) and Salt Slough as is reflected in the decreasing river concentrations.

Median annual boron concentrations have remained relatively constant at the Hills Ferry Road monitoring site since WY 90 with values near 2 mg/L, showing little influence from the WY type, especially the above normal WY 93. Median boron concentrations at the Crows Landing Bridge site, however, remained near 1.0 mg/L between WYs 87 and 92 but responded to increased dilution flows from the Merced River during WY 93. The WY 93 median boron concentration at the Crows Landing Bridge site (0.66 mg/L) was the lowest median value since WY 87. By WY 94, the median value had return to 1.1 mg/L which is similar to levels seen during previous critically dry conditions.

Median annual selenium concentrations have fluctuated at both the Hills Ferry Road and Crows Landing Bridge sites since WY 86 (Figure 4). During WY 93, median selenium at the Hills Ferry Road site increased to 11 $\mu\text{g/L}$ as compared to 8.6 $\mu\text{g/L}$ during WY 92. The increase may be due in part to increased leaching being practiced in the Grassland area after six consecutive critical WYs. In contrast, downstream at the Crows Landing Bridge site, median selenium concentrations for the same time period decreased to 3.8 $\mu\text{g/L}$, the lowest median for the period of record. Increased dilution flows from storm runoff, operational spills and natural runoff in the Merced River may account for some of the downstream decreases.

During WY 94, median selenium concentrations increased at the Hills Ferry Road site. A similar increase at the Crows Landing Bridge site may reflect the possible loss of dilution flows from the Merced River. The annual median selenium concentration at the Hills Ferry Road site of 13 $\mu\text{g/L}$ is the highest recorded since monitoring began in WY 86. The median concentration at the Crows Landing Bridge site (6.1 $\mu\text{g/L}$) is as high as any since WY 90.

Loads of Pollutants in the San Joaquin River

During WYs 93 and 94, loads to the San Joaquin River changed dramatically from previous years. After five years of decreases in salt, boron, and selenium loads (WYs 88 through 92), loads in WYs 93 and 94 increased to 1988-89 levels (Table 8). Figures 5, 6, and 7 compare the annual loads for salt (in terms of TDS), boron, and selenium, respectively, with their average flow weighted concentrations. The annual loads presented are the sum of each WY's 12 calculated monthly loads while the flow weighted average annual concentration was computed by dividing the total annual load by the total annual discharge.

The pattern depicted in Figures 5 through 7 generally mirrors that observed in the Drainage Study Area (DSA), Mud Slough (north), and Salt Slough (Vargas, *et al.*, 1995). These two sloughs account for 57% of the salt load, 71% of the boron load, and 86% of the selenium load in the San Joaquin River (Figure 8), so the consistent load pattern between the sloughs and the river is expected. The load increases observed in WY 93, are likely due to the end of the drought in 1993 and the corresponding increase in water supply in the Grassland

Table 8. Actual and Normalized Selenium, Boron and Salt Concentration within, and Loads Entering, the San Joaquin River at Crows Landing.

Water Year	Actual					
	Concentration			Loads		
	Se (ug/L)	B (mg/L)	TDS (mg/L)	Se (lbs)	B (lbs/1000)	TDS (tons)
1986	1.6	0.39	347	11158	2771	1240708
1987	5.2	0.96	788	8834	1621	663943
1988	6.6	1.21	977	9305	1716	691399
1989	7.3	1.19	950	8249	1346	535909
1990	7.3	1.21	997	7594	1250	513859
1991	5.9	1.12	1024	4225	808	369351
1992	4.5	1.00	907	3397	749	340693
1993	3.9	0.79	593	9193	1684	702653
1994	5.6	0.94	775	8044	1381	559069

Water Year	Data Normalized to Average Value					
	Concentration			Loads		
	Se (ug/L)	B (mg/L)	TDS (mg/L)	Se (lbs)	B (lbs/1000)	TDS (tons)
1986	0.29	0.40	0.43	1.43	1.87	1.99
1987	0.99	0.99	0.96	1.14	1.09	1.06
1988	1.24	1.25	1.20	1.20	1.16	1.11
1989	1.38	1.23	1.16	1.06	0.91	0.86
1990	1.38	1.24	1.21	0.98	0.84	0.82
1991	1.10	1.15	1.25	0.54	1.55	0.59
1992	0.85	1.03	1.11	0.44	1.51	0.55
1993	0.73	0.73	0.73	1.18	1.14	1.13
1994	1.05	0.99	0.92	1.03	0.93	0.90

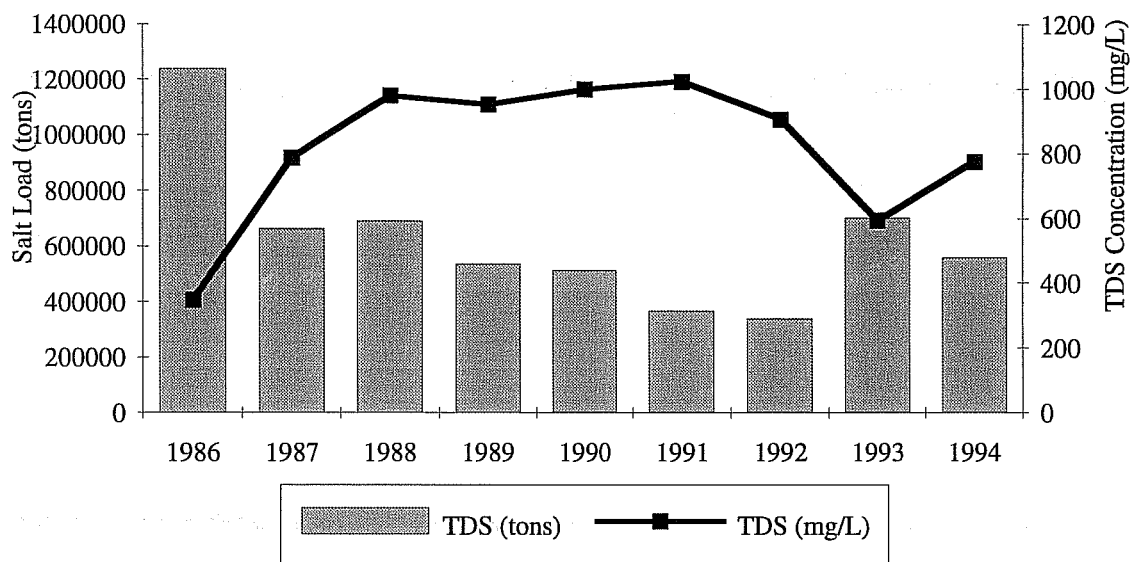
Table 9. Number of Exceedances of Selenium and Boron Objectives

Water Year	Selenium		Boron	
	Crows Ldg	Hills Ferry	Crows Ldg	Hills Ferry
1987	2*	7*	3*	0**
1988	3	7	4	2
1989	3	7	4	0
1990	4	6	7	5
1991	3	6	4	2
1992	1	4	2	3
1993	2	6	3	3
1994	3	7	2	5

Boron objective at Hills Ferry applies from March 15 - September 14

* No sample was collected in March **No samples were collected from March to May.

**Figure 5. Salt Concentrations and Loads at the Crows Landing Bridge
Site: WY 86-94.**



**Figure 6. Boron Concentrations and Loads at the Crows Landing Bridge
Site: WYs 86-94.**

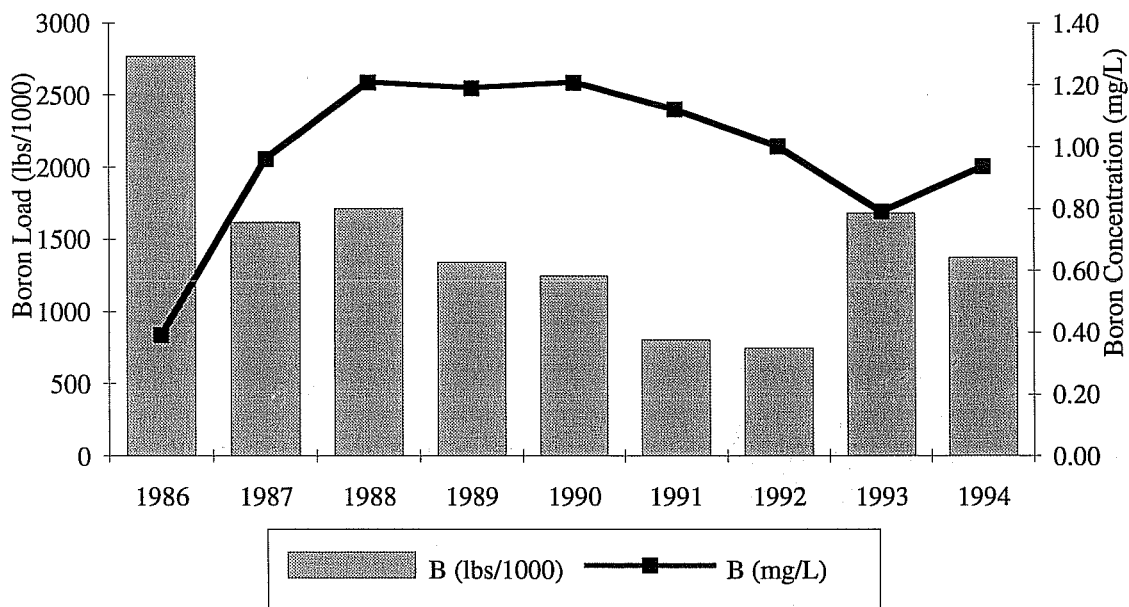
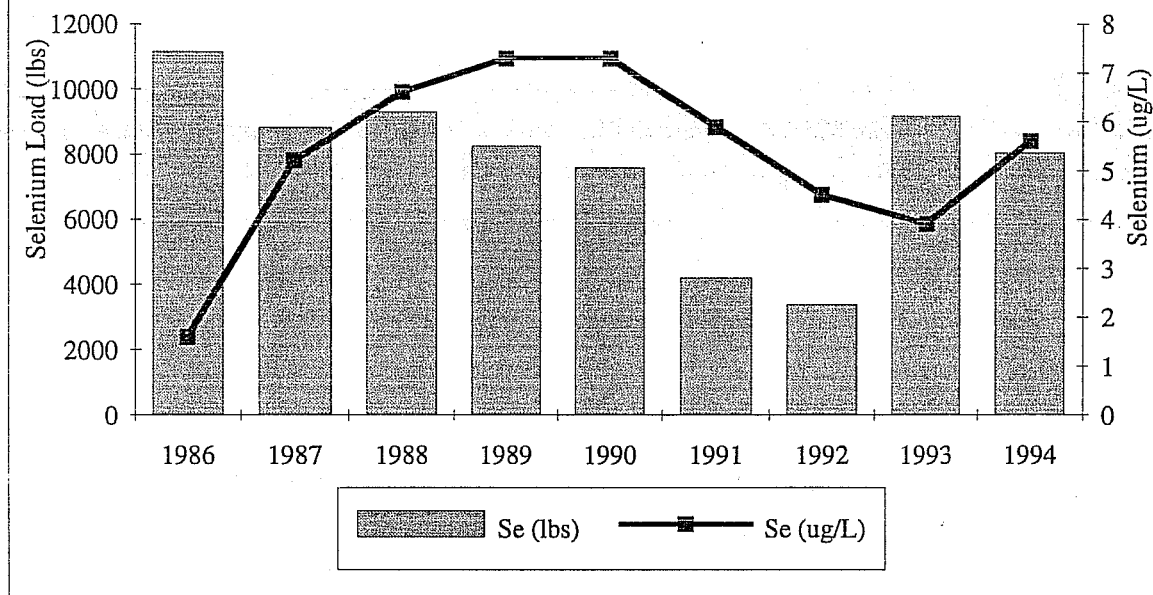


Figure 7. Selenium Concentrations and Loads at the Crows Landing Bridge Site: WYs 86-94.



watershed which allowed leaching of salt buildup that occurred during the 6-year drought period. WY 94, however, was critically dry. Carryover storage from WY 93, groundwater pumping, water exchanges, and cropping pattern changes may have provided a much greater supply of water to the Grasslands than that which was available at the height of the drought thus resulting in greater deep percolation to shallow groundwater.

Annual average selenium, boron, and salt concentrations continued to decrease through WY 93. Concentrations of all constituents, however, increased in WY 94, but were well below historical peak values. Although the effect of water conservation has been to increase average annual concentrations in the DSA and sloughs, concentrations in the river are influenced by the amount of dilution provided by the Merced River along with discharges from the sloughs. Years of high loads can be mitigated by high Merced River flows, as in WYs 86 and 93. The mitigating effect of Merced River flows is less pronounced in critically dry years with higher loads generally corresponding to higher constituent concentrations.

Comparison to Water Quality Objectives

A comparison of monthly mean boron concentrations at the Hills Ferry Road site for WYs 93 and 94 is depicted in Figure 9. The mean concentrations varied throughout WY 93 with a peak occurring in December 1992 and concentrations remaining elevated from May through August 1993. During WY 94, mean monthly boron concentrations did not show the December increase but increased rapidly in March 1994, exceeding the 2.0 mg/L adopted water quality objective, and then remained above the objective through August 1994. The

Figure 8. Comparison of Drainage Study Area (DSA) , Salt Slough (SS) and Mud Slough (MS) Flow and Loads to the San Joaquin River at the Crows Landing Bridge Site (Crows)

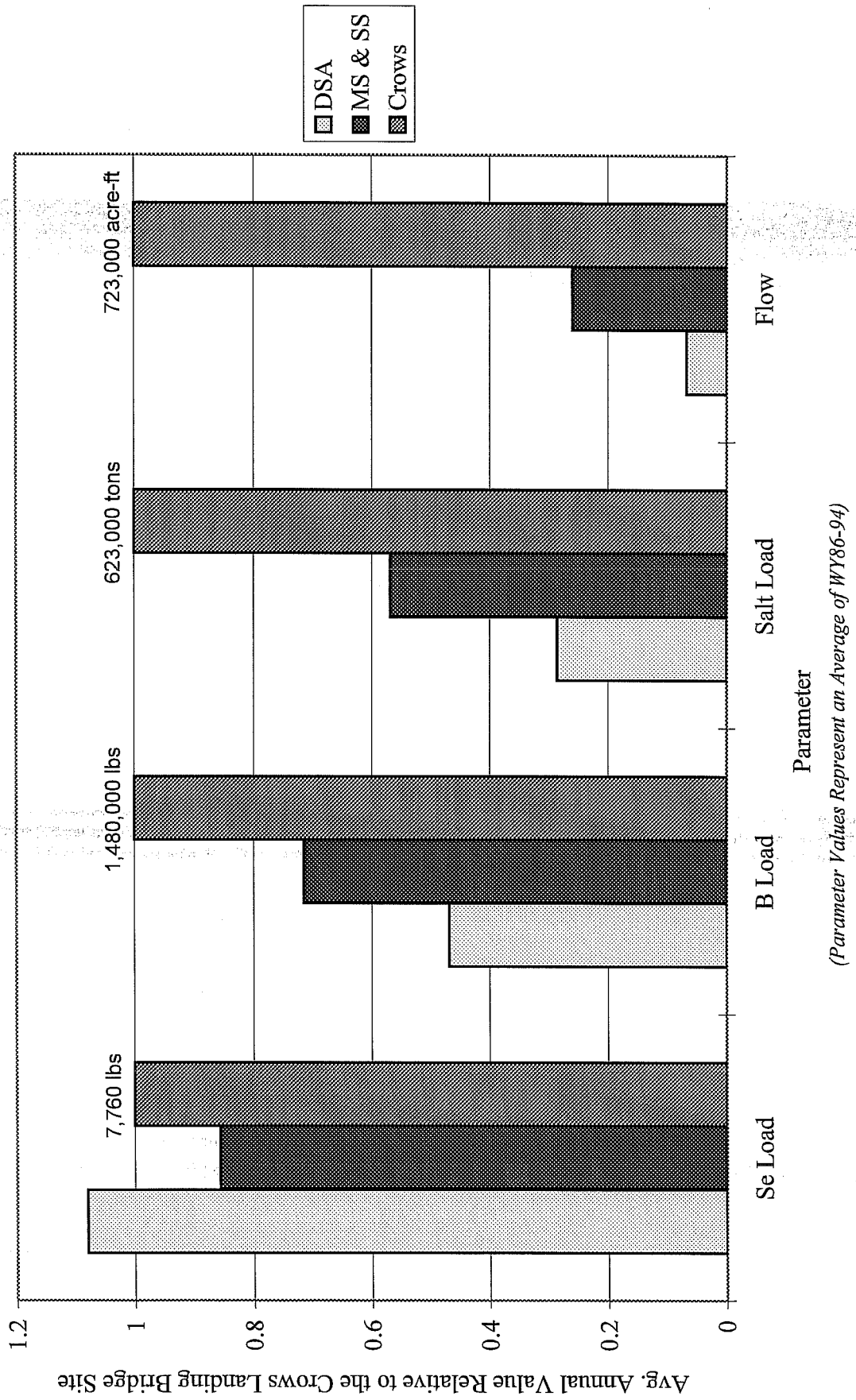


Figure 9. Monthly Mean Boron Concentrations in the San Joaquin River at the Hills Ferry Road Site.

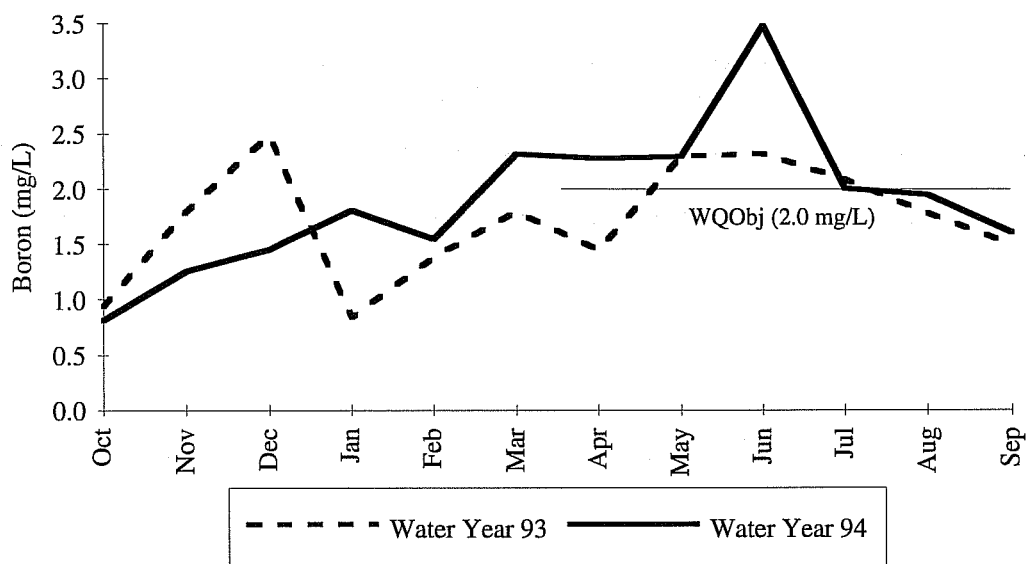
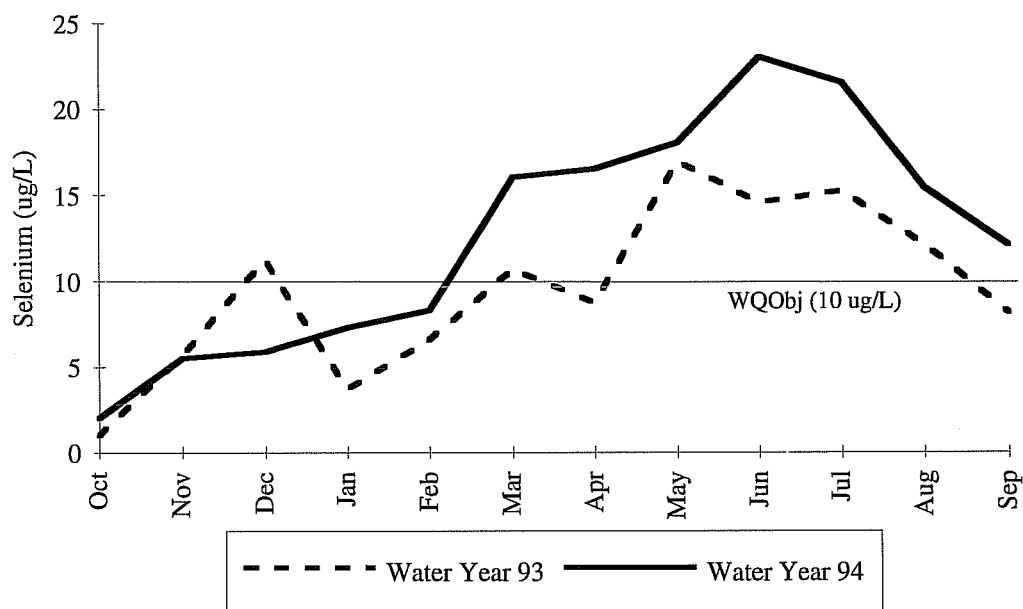


Figure 10. Monthly Mean Selenium Concentrations in the San Joaquin River at the Hills Ferry Road Site.



peak monthly mean boron concentration (3.5 mg/L) occurred in June 1994. The water quality objective depicted on Figure 9 is for all water year types as no critical year relaxation was adopted.

Monthly mean selenium concentrations at the Hills Ferry Road site were lower during WY 93 as compared to WY 94, except for December 1992 (Figure 10). For all water year types, the mean monthly selenium water quality objective at the Hills Ferry Road site is 10 $\mu\text{g/L}$. This objective, although not implemented in WY 93, was exceeded at this site six months out of twelve with the greatest frequency occurring after March. During WY 94, the selenium WQObj was exceeded continuously from March through September 1994. These periods of elevated concentrations correspond to periods of pre-irrigation or intensive irrigation in the Grasslands drainage basin.

As specified in the basin plan amendment adopted in December 1988, compliance monitoring for selenium and boron WQObjs will occur on the San Joaquin River at the Crows Landing Bridge site. The Crows Landing Bridge site is downstream of the Merced River inflow and also receives water from agricultural return flows and groundwater seepage. As shown in Table 3, the water quality objective used for the river at the Crows Landing Bridge site depends on the water year type. Slightly relaxed objectives are implemented during critical water years reflecting the lack of good quality dilution flows from excess tailwater and/or flows from the eastside tributaries.

During WY 93, an above normal water year, boron WQObjs were exceeded in December 1992 and March and July 1993 at the Crows Landing Bridge site (Figure 11). WY 94, a critical water year, had a boron WQObj of 1.3 mg/L. The WY 94 mean monthly objective for boron was exceeded during two months; March and June 1994. Overall mean monthly boron concentrations for critical WY 94, were also consistently elevated over the above normal WY 93, except for the month of December. Seasonal patterns for elevated concentrations during the two water years were similar but not completely consistent. The inconsistency is likely due to differences in periods of runoff from pre-irrigation and crop irrigation.

Figure 12 shows the average monthly selenium concentrations at the Crows Landing Bridge site during WYs 93 and 94. Seasonal patterns in selenium concentration are evident with peak concentrations occurring in March and then again in June or July. WY 93 showed lower overall selenium concentrations than WY 94 but still exceeded the adopted 5.0 $\mu\text{g/L}$ WQObj in both March and July 1993. WY 94 followed the same pattern for elevated selenium concentrations, however, since it was a critical water year, the WQObj for selenium was relaxed to 8 $\mu\text{g/L}$. This WQObj was exceeded in March and June 1994. The elevated concentrations occurred during typical periods of pre-irrigation and crop irrigation.

A comparison was made of all the monthly mean selenium concentrations which would have exceeded WQObjs in the San Joaquin River at the Crows Landing Bridge and Hills Ferry Road sites if the objectives had been in place since 1986 (Table 9). Time periods of selenium

Figure 11. Monthly Mean Boron Concentrations in the San Joaquin River at the Crows Landing Bridge Site: WYs 93-94.

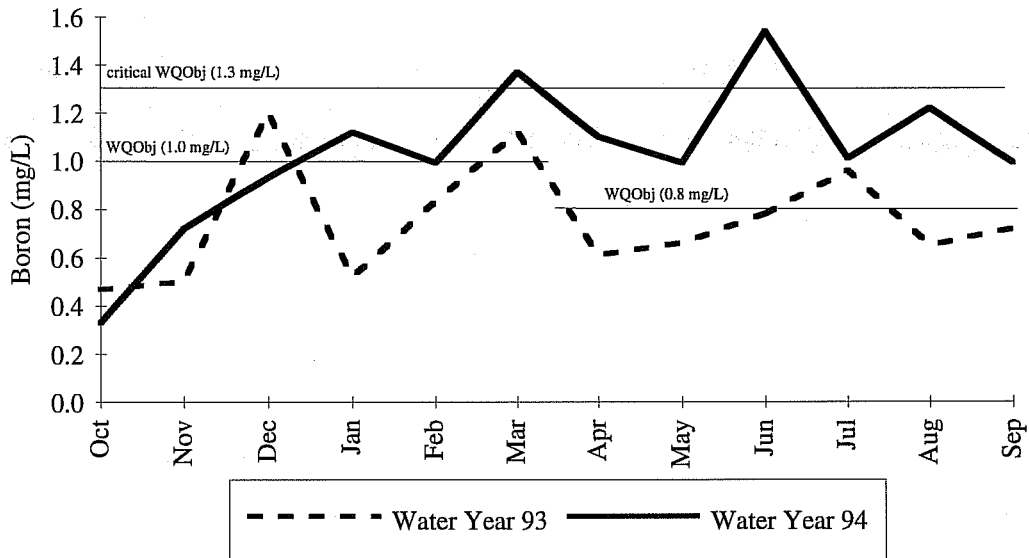
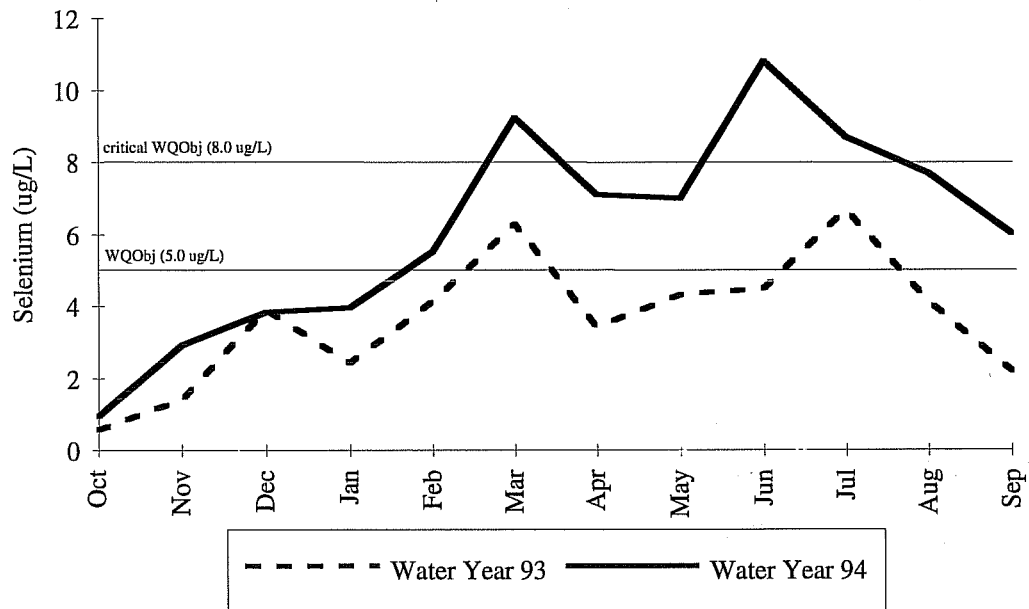


Figure 12. Monthly Mean Selenium Concentrations in the San Joaquin River at the Crows Landing Bridge Site: WYs 93-94.




WQObj exceedance at the Crows Landing Bridge site appear to be centered between February and April as well as June and July (Table 10). These two time periods correspond to typical periods of pre-irrigation and intensive crop irrigation in the Grassland area watershed.

Table 10. Mean Monthly Selenium Water Quality Objective Exceedances in the San Joaquin River at Crows Landing: WYs 86 - 94.

Water Year	Type	Se (ug/L) WQObj	Monthly Mean Water Quality Objective Exceeded											
			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1986*	Wet	5												
1987*	Critical	8												
1988¥	Critical	8												
1989¥	Critical	8												
1990¥	Critical	8												
1991¥	Critical	8												
1992¥	Critical	8												
1993¥	Above Normal	5												
1994¥	Critical	8												

*samples were collected once a month

¥samples were collected weekly and the concentrations averaged

 = exceedance of objective

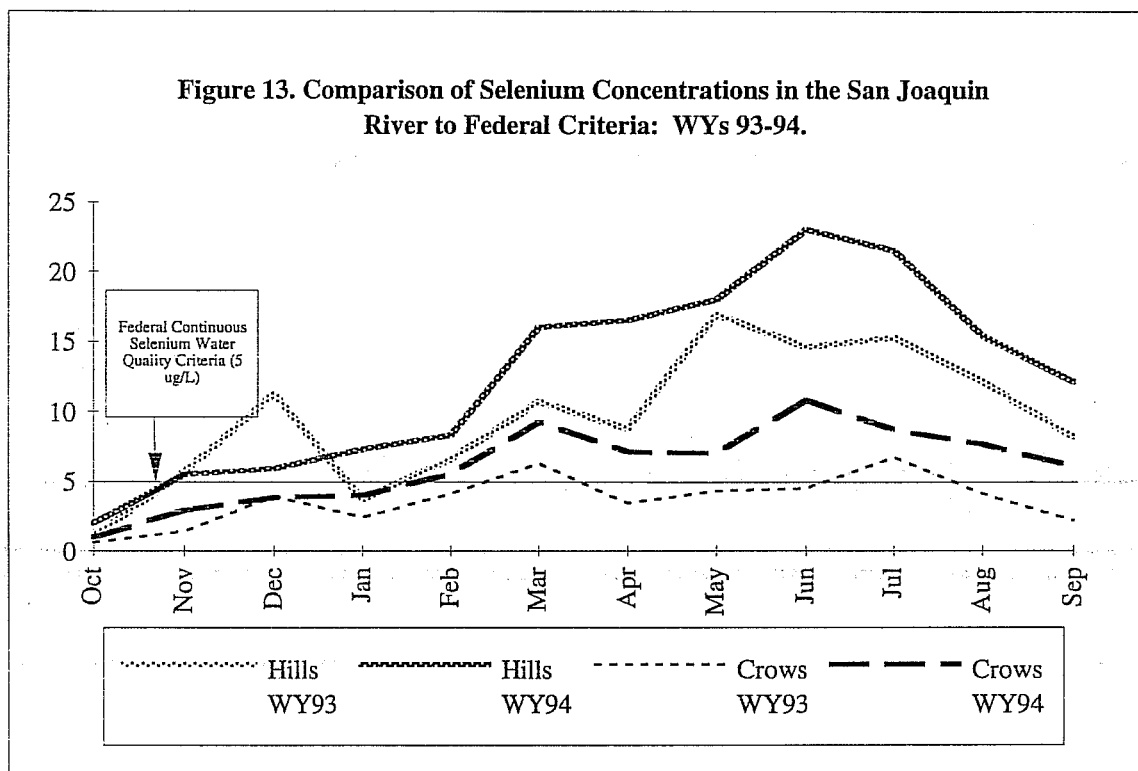
On 22 December 1992, the U.S. Environmental Protection Agency (EPA) finalized promulgation of water quality standards for all states which they felt had not satisfied section 303(c)(2)(b) of the Clean Water Act. Section 303(c)(2)(b) required the setting of enforceable numeric water quality criteria on all surface water of the Nation. California was included in the promulgation for a limited number of criteria and specifically included for a maximum criteria of 20 $\mu\text{g/L}$ in the river from Sack Dam to the mouth of the Merced River and a continuous (four-day average) criteria of 5 $\mu\text{g/L}$ for selenium in the San Joaquin River from Sack Dam to Vernalis.

Reviewing the WYs 93 and 94 data in light of the U.S. EPA maximum concentration criteria would result in one exceedance of the 20 $\mu\text{g/L}$ criteria at Hills Ferry Road during WY 93 and an additional seven exceedances during WY 94. Selenium concentrations at the Fremont Ford site exceeded 20 $\mu\text{g/L}$ seven times in WY 93 and 19 times in WY 94. All the exceedances occurred in grab samples collected between March and September.

The U.S. EPA selenium criteria (5 $\mu\text{g/L}$) is similar to that normally used by the state but lower than the 8.0 $\mu\text{g/L}$ objective which the state allows during a critical year. The federal criteria, however, is based on a four-day continuous average, not the monthly mean concentration used for the state WQObj. Data collected during this monitoring program is not sufficient to calculate a continuous four-day average concentration. For the sake of comparison, however, the average monthly mean selenium concentrations at the Hills Ferry Road and Crows Landing Bridge sites were compared to the federal criteria (Figure 13).

During WY 93, the mean monthly selenium concentration at the Crows Landing Bridge site exceeded 5 $\mu\text{g/L}$ in March and July. During WY 94, mean monthly selenium concentrations at the same site exceeded 5 $\mu\text{g/L}$ during seven months out of twelve (February through September).

Upstream of the Merced River inflow, at the Hills Ferry Road site, a state WQObj of 10 $\mu\text{g/L}$ selenium was implemented during WY 94. The federal criteria of 5 $\mu\text{g/L}$ was in place for both WYs 93 and 94. Comparing the monthly mean selenium concentrations to the continuous four-day average federal criteria at the Hills Ferry Road site demonstrates an almost continuous exceedance of the criteria (Figure 13). The only months when the mean monthly selenium concentrations at the Hills Ferry Road site did not exceed 5 $\mu\text{g/L}$ was during October 1992, January 1993, and October 1993.



Other Elements of Concern

Molybdenum data collected from the San Joaquin River at the Lander Avenue site indicated three exceedances in WY 93 of both the adopted 19 $\mu\text{g/L}$ monthly mean WQObj and the adopted maximum concentration. The exceedances occurred during October, November and December of 1992 with concentrations ranging from 51 to 55 $\mu\text{g/L}$. For the remainder of WY 93 (January to September 1993), molybdenum concentrations at the Lander Avenue site remained below 16 $\mu\text{g/L}$. No exceedances occurred at this site during WY 94.

Concentrations ranged from 1 to 17 $\mu\text{g/L}$ with an annual median of 10 $\mu\text{g/L}$. Flow at the Lander Avenue site is primarily groundwater accretion. The flow reflects the diversion of the

San Joaquin River head waters into the Friant-Kern Canal and a lack of agricultural return flows upstream of this site. Molybdenum levels in the groundwater near the sampling site can range up to 1,000 $\mu\text{g/L}$ (SJVDP, 1990). Since flows are low and ground water molybdenum levels are high, the high levels of molybdenum found at the Lander Avenue site are likely due to groundwater accretions.

Total recoverable chromium, copper, lead, nickel, and zinc were analyzed at the Lander Avenue, Fremont Ford, Hills Ferry Road, Crows Landing Bridge, and Airport Way sites. Copper, lead, nickel, and zinc water quality criteria vary with hardness (Marshack, 1993). Toxicity is not expected to occur from these four elements due to the combination of high median hardness (197 to 448 mg/L) in San Joaquin River water and the low levels of the four elements measured at these sites. Total recoverable chromium was analyzed to determine whether potential problems related to hexavalent chromium exist. Total chromium values exceeded the toxicity value (11 $\mu\text{g/L}$) of hexavalent chromium at least once at each site sampled. The two highest total chromium values recorded were both 18 $\mu\text{g/L}$ and were collected at the Airport Way site on 13 August 1993 and 29 June 1994. No measurements for hexavalent chromium are available.

The San Joaquin River between Sack Dam and Vernalis contains a high suspended sediment load. Therefore, in addition to the samples for total recoverable trace elements, monthly water samples for total dissolved trace elements were also collected at the Hills Ferry Road site to distinguish between constituent concentrations in the water column and concentrations associated with the suspended material. Table 11 shows the comparison of total vs. dissolved trace elements for the Hills Ferry Road site. In almost all cases, the filtered samples used for dissolved analysis, show no detectable levels of the element of concern. In particular, all dissolved chromium concentrations were reported below analytical detection limits of either 1 or 5 $\mu\text{g/L}$ even when total chromium concentrations reached 12 $\mu\text{g/L}$. Hexavalent chromium exists in an aqueous form under natural stream conditions, therefore, dissolved chromium concentrations should over estimate the amount of hexavalent chromium present. Since the majority of chromium in the water column appears to be attached to suspended material, hexavalent chromium should not be of concern in this system.

Dissolved copper, nickel, and zinc were reported at concentrations above the detection limit on a number of separate occasions. However; a comparison between total recoverable and dissolved trace elements indicates that the greatest portion of the trace elements is likely bound up in the suspended material.

Table 10. Total Recoverable vs. Dissolved Trace Element Concentrations for the San Joaquin River at the Hills Ferry Road Site: WYs 93-94.

Date	Concentrations (ug/L)									
	C r		C u		P b		N i		Z n	
	Total	Diss	Total	Diss	Total	Diss	Total	Diss	Total	Diss
WY 93										
10/29/92	6	<5	10	<6	<25	<25	28	13		
11/30/92	5	<5	4	3	<5	<5	<5	<5		
12/30/92	<5	<5	2	1	<5	<5	<5	<5	6	3
1/12/93	12	<5	9	5	<5	<5	11	6	11	9
1/28/93	8	<5	5	2	<5	<5	<5	9	14	20
2/25/93	9	<5	9	2	<5	<5	9	<5	23	10
3/25/93	7	<5	7	4	<5	<5	7	<5	9	2
4/29/93	6	<5	3	2	<5	<5	7	<5	15	3
6/24/93	10	<5	6	2	<5	<5	9	12	10	4
7/29/93	12	<5	7	2	<5	<5	7	<5	15	1
8/12/93	18	<5	5	2	<5	<5	6	<5	9	3
8/26/93	10	<1	5	<1	<5	<5	8	<5	11	3
9/23/93	6	<1	3	3	<5	<5	<5	<5	4	3
WY 94										
10/28/93	8	<1	5	2	<5	<5		7	11	2
11/28/93	5	<1	4	3	<5	<5	<5	<5	5	2
12/28/93	6	<1	7	3	<5	<5	15	22	5	<1
1/27/94	11	<5	11	6	7	<5	21	8	7	6
2/23/94	11	<1	5	8	<5	<5	14	9	10	
3/31/94	8	<1		2	<5	<5	7	<5	13	14
4/27/94	6	<1	4	5	<5	<5	6	<5	7	<1
5/25/94	9	1	6	3	<5	<5	6	<5	9	4
6/29/94	18	2	8	2	<5	<5	13	<5	16	3
7/27/94	9	<1	7	2	3	<10	11	<5	<10	3
8/31/94		<10		<20		<50		<20		<5

Range of acceptable recoveries for each element is as follows (in ppb):

Chromium ± 5 Copper ± 5 Lead ± 8 Nickel ± 6 Zinc ± 6

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Appendix A

Mineral and Trace Element Data for the Lower San Joaquin River

San Joaquin River at Lander Avenue (State Highway 165) (MER522)

Location: Latitude 37° 17' 43" Longitude 120° 51' 01". In NE 1/4, NE 1/4, Sec. 27, T.7S., R.10E. East Bank,
50 ft West of Lander Avenue (Highway 165), 2.3 mi. south of Stevinson. River mile 132.9

Date	Time	Temp °F	pH	EC µmhos/cm	Se	Mo	Cr	Cu µg/L	Ni	Pb	Zn	B	Cl mg/L	SO4	HDNS
10/2/92	1025	74	8.2	4030	0.4							1.0			
10/9/92	1040	68	8.1	4050	0.4							1.1			
10/16/92	1230	70	8.2	3980	0.3							0.89			
10/23/92	1215	70	8.2	3920	0.4							0.89			
10/29/92	750	65	8.2	3950	0.2	51						0.94	1050	188	207
11/6/92	1020	66	8.3	4060	0.2							1.1			
11/13/92	1035	58	8.3	4050	0.6							1.1			
11/30/92	920	48		4000	0.3	55						0.97	983	207	218
12/4/92	1030	52	8.2	3950	0.2							0.93			
12/14/92	1040	48	8.6	3860	0.3							0.94			
12/22/92	1130	48	8.3	3910	0.4							0.97			
12/30/92	1100	47		3850	0.2	51	<5	1	<5	<5	2	0.92	865	161	197
1/8/93	1040	56	8.2	300	0.6							0.06			
1/15/93	1155			130	0.5							0.04			
1/22/93	1045	55	8.9	170	0.5							0.05			
1/28/93	855	46	8.7	250	0.8	2	7	6	<5	<5	8	0.04	15.9	14.8	62.0
2/4/93	1140	54	8.1	490	1.0							0.13			
2/10/93	1050	56		190	0.5							0.07			
2/19/93	1210	56	7.9	490	0.5							0.10			
2/24/93	1540	57	8.3	210	0.3		17	5	6	10	14	0.04	15.6	16.1	74.0
3/5/93	1125	62	8.3	360	0.7							0.08			
3/12/93	1145	67	7.6	699	0.4							0.12			
3/18/93	1200	66	8.0	844	0.5							0.15			
3/26/93	1255	60	7.9	800	0.4	4	<5	3	<5	<5	6	0.13	102	63.4	194
4/2/93	1305	64	7.8	300	0.5							0.06			
4/9/93	1344	68	8.4	350	0.6							0.06			
4/16/93	1200	66	8.5	230	0.4							0.06			
4/23/93	1100	67	8.7	738	0.3							0.13			
4/30/93	1200	72	8.2	1230	0.4	10	<5	3	6	<5	9	0.23	217	99.8	200
5/7/93	1205	71	8.2	1640	0.7							0.28			
5/14/93	1133	75	8.1	1790	1.3							0.36			
5/21/93	1210	74	7.8	1570	0.8							0.32			
5/28/93	1122	74	7.9	1280	0.3	9	<5	5	10	<5	<1	0.24	200	102	234
6/4/93	1035	73	8.3	814	0.4							0.17			
6/11/93	1020	73	8.1	757	0.4							0.15			
6/18/93	1045	83	8.2	1290	0.6							0.25			
6/25/93	1220	86	7.8	1580	0.5		<1	3	<5	<5	<1	0.28	282	148	245
7/2/93	1048	82	7.5	1640	0.5							0.34			
7/9/93	915	80	7.5	1250	0.8							0.28			
7/16/93	1127	77	8.4	1330	0.5							0.30			
7/23/93	1129	82	8.0	1090	0.5							0.26			
7/30/93	1052	78	7.8	1220	0.6	12						0.28	229	98.2	175
8/6/93		82	8.0	1320	0.6							0.33			
8/12/93	1415	83	7.3	1210	0.7	11	2	2	<5	<5	38	0.38	238	104	204
8/20/93	915	76	7.5	1110	0.5							0.32			
8/27/93	1054	78	7.7	1190	0.5	10	3	<1	<5	<5	4	0.33	191	79.2	188
9/3/93	1333	83	7.7	1140	0.7							0.31			
9/10/93	1355	82	7.7	991	0.4							0.24			
9/17/93	1310	71	8.1	1620	0.3							0.38			
9/24/93	1120	74	8.4	1510	0.1	16	4	2	<5	<5	<1	0.37	292	68.1	158
Count		49	46	50	50	11	10	10	10	10	10	50	13	13	13
Min		46	7.3	130	0.1	2	<1	<1	<5	<5	2	0.04	15.6	14.8	62
Max		86	8.9	4060	1.3	55	17	6	10	10	38	1.1	1050	207	245
Mean		68	8.1	1650	0.5	21	4	3	3	2	8	0.39	360	104	181
Geo Mean		67	8.1	1100	0.4	13	2	2	2	2	3	0.25	200	82.2	170
Median		70	8.1	1230	0.5	11	2	3	<5	<5	5	0.28	229	99.8	197

San Joaquin River at Lander Avenue (State Highway 165) (MER522)

Location: Latitude 37° 17' 43" Longitude 120° 51' 01". In NE 1/4, NE 1/4, Sec. 27, T.7S., R.10E. East Bank,
50 ft West of Lander Avenue (Highway 165), 2.3 mi. south of Stevinson. River mile 132.9

Date	Time	Temp F	pH	EC umhos/cm	Se	Mo	Cr	Cu ug/L	Ni	Pb	Zn	B	Cl mg/L	SO4	HDNS
10/1/93	1317	79	7.7	1710	0.2							0.41			
10/8/93	1300	72	8.2	1950	0.2							0.48			
10/15/93	1025	70	8.2	1560	<0.2							0.34			
10/21/93	805		8.4	204	0.4							<0.05			
10/29/93	1253	66	7.9	288	0.2	3	3	3	<5	<5	13	0.06	37.7	11.0	48.1
11/5/93	845	60	7.8	225	0.3							0.05			
11/12/93	1109	60	7.8	361	0.8							0.09			
11/22/93	1157	56	8.1	707	0.6							0.17			
11/30/93	1115	55	7.9	955	0.4	11	2	2	<5	<5	2	0.20	158	40.9	108
12/3/93	1040	53	8.5	990	<0.2							0.20			
12/10/93	1310	56	8.6	1060	0.3							0.27			
12/17/93	1204		8.4	973	0.3							0.19			
12/28/93	1250	48	7.9	925	0.3	8	4	<1	5	<5	<1	0.19	137	50.1	141
1/7/94	1220	46	8.2	702	1.3							0.34			
1/13/94	1713	50	8.4	920	1.3							0.65			
1/21/94	1216	52	8.9	1040	0.9							0.34			
1/27/94	1336	51	8.1	300	0.4	2	8	7	9	<5	11	0.09	34.2	19.2	63.9
2/3/94		52	8.1	742	<0.2							0.18			
2/11/94	1258	54	7.2		0.5							0.06			
2/17/94	730	53	7.7	631	0.6							0.14			
2/23/94	1358	54	7.9	324	0.3	1	14	10	11	<5	10	0.07	30.9	27.6	98.4
3/4/94	1148	62	8.0	1100	0.6							0.22			
3/9/94	740	60	7.9	1280	1.5							0.31			
3/16/94	1115	65	8.1	866	0.2							0.14			
3/23/94	1054	62	9.0	1190	0.6							0.29			
3/31/94	1605	68	9.2	908	0.5	6	6	14	<5	<5	3	0.23	151	84.7	178
4/6/94	1240		9.0	1170	0.6							0.28			
4/15/94	1145	73	8.4	1320	0.3							0.29			
4/21/94	1305	72	8.1	1470	0.3							0.31			
4/27/94	1145	62	8.1	1180	0.3	11		2	<5	<5	2	0.24	208	77.8	203
5/4/94	1230	71	9.0	1010	0.9							0.24			
5/10/94	1515	82	8.5	1190	0.9							0.26			
5/16/94	1205	70	8.9	1410	1.8							0.29			
5/25/94	1020	77	7.6	1090	0.5	8	1	3	<5	<5	4	0.28	219	106	239
6/1/94	1245	80	8.4	1130	1.3							0.25			
6/8/94	951	67	8.4	1280	1.0							0.25			
6/15/94	1200	74	8.2	1690	0.4							0.40			
6/21/94	1139	77	8.2	1570	1.2							0.32			
6/29/94	850	79	7.8	1690	0.4	13	3	3	<5	<5	6	0.36	346	120	279
7/6/94	1145	80	8.1	1520	0.6							0.31			
7/13/94	1120	82	8.5	1620	0.6							0.39			
7/21/94	1350	82	8.5	1480	0.5							0.38			
7/27/94	915	72	8.7	1410	0.8	12	2	2	3	3	<10	0.34	260	130	190
8/3/94	1140	80	8.4	1430	0.2							0.38			
8/10/94	1240	81	8.6	1450	1.1							0.42			
8/16/94	1114	81	8.2	1610	<2							0.42			
8/24/94	1135	79	8.0	1640	0.7							0.45			
8/31/94	1600	84	8.7	1600	<0.2	14						0.43			230
9/7/94	1154	78	8.2	1400	0.9							0.33			
9/14/94	1140	75	8.9	1390	0.9							0.30			
9/22/94	1210	76	7.9	1570	0.8							0.40			
9/29/94	1225	74	8.0	1730	0.3	17						0.43			150
Count		49	52	51	52	12	9	10	10	10	10	52	10	10	12
Min		46	7.2	204	<0.2	1	1	<1	3	3	<1	<0.05	30.9	11	48.1
Max		84	9.2	1950	1.8	17	14	14	11	3	13	0.65	346	130	279
Mean		68	8.2	1160	0.6	9	5	5	4	1	5	0.28	158	66.7	161
Geo Mean		67	8.2	1030	0.4	7	4	3	2	1	3	0.23	118	51.5	143
Median		70	8.2	1190	0.5	10	3	3	<5	<5	4	0.29	155	64.0	164

San Joaquin River at Fremont Ford (MER538)

Location: Latitude 37° 18' 34" Longitude 120° 55' 45" In NW 1/4, NW 1/4, Sec. 24 T.7S., R.9E. West Bank
at Fremont Ford State Recreation Area, 50ft. south of Highway 140. 5.4 mi. NE of Gustine. River mile 125.2

Date	Time	Temp °F	pH	EC µmhos/cm	Se	Mo	Cr	Cu µg/L	Ni	Pb	Zn	B	Cl	SO4	HDNS
10/2/92	1035	70	7.6	2410	1.2							0.80			
10/9/92	1010	65	7.9	2200	0.8							0.87			
10/16/92	1200	68	8.0	2680	0.6							0.87			
10/23/92	1155	65	8.3	2100	0.8							0.76			
10/29/92	725	62	7.2	2250	0.6	8						0.92	475	316	448
11/6/92	1040	64	8.3	2330	9.7							2.1			
11/13/92	1045	54	8.3	3060	14.4							3.0			
11/30/92	945	48		2740	0.6	9						1.0	597	367	525
12/4/92	1040	50	8.5	2470	0.6							1.1			
12/14/92	1020	47	8.1	3040	20.8							3.4			
12/22/92	1145	48	8.3	3710	20.8							3.4			
12/30/92	1050	46		3710	0.7	12						1.3	762	511	699
1/8/93	1050	56	7.9	1770	9.0							1.4			
1/15/93	1210			210	0.8							0.10			
1/22/93	1055	54	8.7	550	2.3							0.47			
1/28/93	845	46	8.4	1340	9.6							1.1	159	238	263
2/4/93	1200	53	8.0	2680	17.6							2.8			
2/10/93	1100	56		760	3.3							0.55			
2/19/93	1220	56	7.6	2330	14.6							2.1			
2/24/93	1530	57	8.1	1130	6.2							0.96	144	213	254
3/5/93	1140	62	7.8	1520	7.2							1.2			
3/12/93	1200	64	7.3	2820	17							2.1			
3/18/93	1215	66	7.9	610	14							1.8			
3/26/93	1310	61	7.5	2080	11							1.7	325	369	469
4/2/93	1316	64	7.7	1240	5.6							1.0			
4/9/93	1350	68	7.9	1930	11							1.4			
4/16/93	1214	66	8.0	1240	7.7							1.0			
4/23/93	1110	66	7.8	1750	5.8							1.0			
4/30/93	1218	72	7.9	2990	22	14						2.4	442	593	599
5/7/93	1215	71	8.0	2850	22							2.4			
5/14/93	1148	72	7.8	3170	29							2.9			
5/21/93	1227	75	7.7	2660	19							2.5			
5/28/93	1134	72	8.2	1860	10	12						1.6	229	325	341
6/4/93	1045	71	8.1	2140	15							2.0			
6/11/93	1030	73	7.9	2160	15							2.4			
6/18/93	1055	78	8.1	2850	23							3.5			
6/25/93	1245	82	8.1	2350	19							2.4	307	482	487
7/2/93	1059	82	7.8	2350	20							2.5			
7/9/93	900	77	7.4	2280	19							2.2			
7/16/93	1140	76	8.7	1970	17							2.2			
7/23/93	1144	80	8.3	1960	15							2.1			
7/30/93	1116	78	8.2	1870	15	10						2.1	228	379	403
8/6/93	1130	80	8.3	1990	16							2.3			
8/12/93	1435	79	7.9	1780	13	10	6	5	<5	<5	7	1.9	207	338	368
8/20/93	925	74	7.8	1760	13							2.1			
8/27/93	1112	78	7.9	1950	19	8	15	5	11	<5	15	2.2	232	371	465
9/3/93	1401	82	8.0	1400	9.2							1.2			
9/10/93	1415	80	7.9	1620	13							1.6			
9/17/93	1330	69	8.0	2170	12							1.6			
9/24/93	1140	72	8.1	1350	2.6	6	9	6	<5	9	9	0.78	179	172	290
Count		49	46	50	50	9	3	3	3	3	3	50	13	13	13
Min		46	7.2	210	0.6	6	6	5	<5	<5	7	0.10	144	172	254
Max		82	8.7	3710	29	14	15	6	11	9	15	3.5	762	593	699
Mean		66	8.0	2080	11	10	10	5	5	4	10	1.7	330	360	432
Geo Mean		66	8.0	1890	7.3	10	9	5	3	2	10	1.5	289	341	413
Median		68	8.0	2120	12	10	9	5	<5	<5	9	1.7	232	367	448

San Joaquin River at Fremont Ford (MER538)

Location: Latitude 37° 18' 34" Longitude 120° 55' 45" In NW 1/4, NW 1/4, Sec. 24 T.7S., R.9E. West Bank
at Freemont Ford State Recreation Area, 50ft. south of Highway 140. 5.4 mi. NE of Gustine. River mile 125.2

Date	Time	Temp F	pH	EC umhos/cm	Se	Mo	Cr	Cu ug/L	Ni	Pb	Zn	Boron	Cl mg/L	SO4	HDNS
10/1/93	1337	78	7.8	1540	1.2							0.69			
10/8/93	1328	70	8.1	1430	1.5							0.67			
10/15/93	1040	70	8.0	1520	3.5							1.4			
10/21/93	815		7.9	1270	4.7							1.1			
10/29/93	1312	66	7.8	1320	4.0	5						1.2	171	220	292
11/5/93	900	62	7.6	1110	4.8							0.95			
11/12/93	1124	58	7.6	1440	4.6							1.1			
11/22/93	1210	56	7.8	1880	8.8							1.6			
11/30/93	1130	55	7.7	1980	9.7	7		4				1.7	256	350	407
12/3/93	1055	51	7.8	2120	11							1.9			
12/10/93	1320	56	7.8	1740	2.5							1.4			
12/17/93	1214		8.0	1710	7.8							1.6			
12/28/93	1125	48	7.7	2450	11	8	7	7	16	<5	5	2.1	521	512	525
1/7/94	1230	47	7.9	1990	7.5							1.7			
1/13/94	1700	50	7.9	2950	16							2.9			
1/21/94	1228	53	8.3	2840	18							2.6			
1/27/94	1320	52	7.9	2070	11	8		7				1.8	266	333	443
2/3/94	1430	51	7.6	2830	19							2.5			
2/11/94	1320	52	7.5	1220	7.5							1.1			
2/17/94	745	52	7.4	2280	19							2.0			
2/23/94	1331	53	7.8	1280	6.4	2		7				1.1	201	257	275
3/4/94	1200	62	7.7	2600	21							2.3			
3/9/94	1127	64	8.0	2550	22							2.2			
3/16/94	1125	65	7.7	2550	16							2.2			
3/23/94	1106	60	7.6	2730	22							2.7			
3/31/94	1400	68	7.9	2620	22	11						2.6	426	597	598
4/6/94	1256		7.8	2850	21							2.6			
4/15/94	1200	71	7.5	2820	19							2.2			
4/21/94	1320	71	7.8	3010	21							2.8			
4/27/94	1129	62	7.6	2860	21	12		7				2.3	448	541	603
5/4/94	1400	72	7.8	2900	20							2.1			
5/10/94	1530	80	8.0	2210	18							1.9			
5/16/94	1215	69	8.0	3590	32							3.3			
5/25/94	1000	72	6.9	2830	23	13	8	7	5	<5	7	2.7	457	556	583
6/1/94	1255	78	8.0	2580	22							2.6			
6/8/94	1005	65	8.1	3270	28							3.6			
6/15/94	1215	72	8.6	3550	27							4.0			
6/21/94	1153	76	8.2	2970	26							3.2			
6/29/94	830	72	7.2	2860	29	11	16	8	13	<5		3.1	444	639	678
7/6/94	1155	79	7.9	2540	28							2.2			
7/13/94	1145	82	8.2	3010	35							3.2			
7/21/94	1405	80	8.1	2370	23							2.7			
7/27/94	935	73	8.0	2050	17		13	8	11	4	<10	2.1	280	450	390
8/3/94	1150	77	8.2	1980	15							1.9			
8/10/94	1300	80	8.3	2400	26							2.6			
8/16/94	1130	79	7.1	2730	27							3.0			
8/24/94	1145	78	7.9	2270	19							2.4			
8/31/94	1430	81	8.7	2160	16							2.1			450
9/7/94	1210	76	8.1	2060	15							1.6			
9/14/94	1155	74	8.5	2800	26							2.7			
9/22/94	1220	76	8.1	2650	19							1.9			
9/29/94	1150	72	7.8	2350	19							1.9			440
Count		49	52	52	52	9	4	8	4	4	3	52	10	10	12
Min		47	6.9	1110	1.2	2	7	4	5	4	5	0.67	171	220	275
Max		82	8.7	3590	35	13	16	8	16	4	7	4.0	521	639	678
Mean		67	7.9	2340	17	9	11	7	11	2	5	2.1	347	446	474
Geo Mean		66	7.9	2250	14	8	10	7	10	2	4	2.0	325	421	457
Median		70	7.9	2430	19	8	11	7	12	<5	5	2.1	353	481	447

San Joaquin River at Hills Ferry Road (STC512)

Location: Latitude 37° 20' 33" Longitude 120° 58' 38" . In NE 1/4, SE 1/4, NE 1/4, Sec. 9, T. 7S, R.9E. West Bank, 0.9 mi. SE of Hills Ferry Road at an abandoned fallow factory, immediately upstream of Merced River inflow, 3.3 mi. NE of Newman. River mile 118.1

Date	Time	Temp °F	pH	EC µmhos/cm	Se	Mo	µg/L				mg/L				Zn	B	Cl	SO4	HDNS	TDS	CO3	HCO3	T.Alk	Ca	Mg	Na	K	Cr	dissolved µg/L			
							Cu	Ni	Pb	Zn	CO3	HCO3	T.Alk	Ca															Mg	Na	K	Cr
10/2/92	1140	70	7.6	2150	1.2										0.96																	
10/9/92	855	63	7.7	2280	0.8										0.95																	
10/16/92	1320	68	8.2	2580	0.6										0.90																	
10/23/92	1315	68	8.3	2300	1.3										0.91																	
10/29/92	855	62	7.9	2390	1.2	9	6	10	28	<25	8				0.96	459	350	448	1490	<1	276	276	77.0	58.0	315	5.9	<5	<6	13	<25	15	
11/5/92	1545	66	7.6	2250	5.7										1.6																	
11/13/92	1105	55	8.1	2970	10										2.5	510	621	631														
11/30/92	1105	48		2980	0.9	12	5	4	<5	<5	6				1.2	571	462	542	1810	<1	167	167	93.5	71.3	400	5.8	<5	3	<5	<5	16	
12/4/92	1100	50	8.2	2950	0.8										1.2	560	494	549														
12/14/92	950	45	8.0	2580	14										2.8	389	514	635														
12/22/92	1220	49	8.2	3600	15										3.0	593	752	772														
12/30/92	935	45		3650	16	18	<5	2	<5	<5	6				2.9	578	700	721	2580	<1	269	269	142	89.2	535	5.7	<5	1	<5	<5	3	
1/8/93	1145	56	7.8	1910	7.0										1.4	269	353	355														
1/12/93							12	9	11	<5	11																					
1/15/93	1230			430	0.7										0.27	48.3	55.2	116														
1/22/93	1200	54	8.5	630	2.1										0.54	71.2	103	144														
1/28/93	925	46	7.6	1230	5.0	4	8	5	<5	<5	14				1.1	172	215	272	810	<1	161	161	58.5	30.6	164	6.2	<5	2	9	<5	20	
2/4/93	1155	54	9.3	2590	11										2.1	421	509	544														
2/10/93	1200	59		1250	4.1										1.0	144	196	285														
2/19/93	1245	57	7.7	2270	9.0										1.8	316	438	487														
2/25/93	930	57	8.5	768	2.7	2	9	9	9	<5	23				0.57	85	126	171	494	<1	123	123	34.9	20.5	83.5	4.6	<5	2	<5	<5	10	
3/5/93	1230	62	7.8	1490	5.6										1.2	199	272	319														
3/12/93	1335	66	7.4	3030	15										2.2	452	530	601														
3/18/93	1340	67	7.7	2720	8.9										1.8	397	438	513														
3/25/93	1315		7.6	2770	14	9	7	7	7	<5	9				2.4	431	521	601	1520	<1	229	229						4	<5	<5	2	
4/2/93	1354	65	7.8	1300	4.8										0.98	178	221	266														
4/9/93	1455	68	7.9	2190	9.7										1.6	307	384	373														
4/16/93	1240	65	7.9	1380	6.3										1.0	166	221	236														
4/23/93	1140	68	7.8	2050	4.9										1.3	319	322	350														
4/29/93	1120	71	7.9	2500	18	12	6	3	7	<5	15				2.2	374	516	531	1710	<1	198	198	118	57.5	337	5.8	<5	2	<5	<5	3	
5/7/93	1235	71	8.3	2780	17										2.2	401	552	507														
5/14/93	1225	72	7.9	3050	23										2.7	418	655	587														
5/21/93	1305	74	7.7	2770	15										2.2	374	504	537														
5/26/93		70	7.7	2230	13	13									2.0	300	446	469	1440	<1	213	213						5	8	<5	31	
6/4/93	1145	71	8.3	2250	12										2.0	289	410	431														
6/11/93	1135	74	7.9	2270	14										2.3	273	450	464														
6/18/93	1250	80	8.1	2760	15										2.5	398	585	554														
6/24/93	802	70	6.4	2610	17	11	10	6	9	<5	10				2.4	363	548	554	1690	<1	2000	2000						2	12	<5	4	
7/2/93	1254	82	7.1	2410	19										2.3	330	450	512														
7/9/93	800	76	7.1	2250	16										2.1	308	420	473														
7/16/93	1245	76	8.3	1930	14										2.0	244	370	412														
7/23/93	1321	83	7.7	2060	14										2.0	263	360	414														
7/29/93	812	74	5.8	1920	13		12	7	7	<5	15				2.1	249	420	429	643	<1	157	157	99.3	44.2	260	5.4	<5	2	<5	<5	1	
8/6/93	1201	79	7.9	1900	14										1.8	242	381	407														
8/12/93	1645	80	7.6	1740	12	8	8	5	6	<5	9				1.7	209	322	359	1080	<1	<1	156	81.6	37.9	220	5.1	<5	2	<5	<5	3	

San Joaquin River at Hills Ferry Road (STC512) continued:

Date	Time	Temp °F	pH	EC µmhos/cm	Se	Mo	µg/L			mg/L			dissolved µg/L																
							Cr	Cu	Ni	Pb	Zn	B	Cl	SO4	HDNS	TDS	CO3	HCO3	T.Alk	Ca	Mg	Na	K	Cr	Cu	Ni	Pb	Zn	
8/20/93	1040	76	7.6	1660	11							1.8	209	340	361														
8/26/93	1250	78	7.5	1750	12	8	10	5	8	<5	11	1.8	199	323	376	1140	<1	165	165		231	6.1	<1	<1	<5	<5		3	
9/3/93	1501	82	7.5	1460	7.7							1.2	177	269	334														
9/10/93	1520	82	7.5	1570	8.0							1.3	198	272	316														
9/17/93	1440	69	8.1	2210	5.8							1.3	343	455	351														
9/23/93	1240	74	7.3	2530	11	10	6	3	<5	<5	4	2.2	348	458	585	1620	<1	189	189	130	63.5	342	4.8	<1	3	<5	<5	3	
Geo Mean	Count	48	46	50	50	12	13	13	13	13	13	50	45	45	45	13	13	13	9	10	13	13	14	14	14	14	14		
	Min	45	5.8	430	0.6	2	<5	2	<5	<5	4	0.27	48.3	55.2	116	494	<1	123	123	34.9	20.5	83.5	4.6	<5	<1	<5	<5	1	
	Max	83	9.3	3650	23	18	12	10	28	<25	23	3.0	593	752	772	2580	<1	2000	2000	142	89.2	535	8.4	<5	5	13	<5	31	
	Mean	67	7.8	2190	9.6	10	8	6	7	2	11	1.7	314	407	442	1390	<1	319	331	92.8	53.6	297	5.9	1	2	4	2	9	
	Median	66	7.8	2040	6.8	9	7	5	5	5	1	10	1.6	280	369	414	1270	<1	137	224	86.1	49.6	273.1	5.9	1	2	3	1	6
Geo Mean	68	7.8	2250	10	10	10	8	5	7	<5	10	1.8	308	420	448	1490	<1	189	189	93.5	57.8	315	5.8	<5	2	<5	<5	4	

San Joaquin River at Hills Ferry Road (STC512)

Location: Latitude 37° 20' 33" Longitude 120° 58' 38". In NE 1/4, SE 1/4, NE 1/4, Sec. 9, T. 7S, R.9E. West Bank, 0.9 mi. SE of Hills Ferry Road at an abandoned tallow factory, immediately upstream of Merced River inflow, 3.3 mi. NE of Newman. River mile 118.1

Date	Time	Temp F	pH	EC umhos/cm	Se	Mo	Total ug/L					mg/L										Dissolved ug/L							
							Cr	Cu	Ni	Pb	Zn	B	Cl	SO4	HDNS	TDS	CO3	HCO3	TALK	Ca	Mg	Na	K	Cr	Cu	Ni	Pb	Zn	
10/1/93	1458	79	7.9	1960	1.2						0.89																		
10/8/93	1444	70	8.1	1550	1.4						0.70	248	227	315															
10/15/93	1235	70	7.9	1030	1.3						0.61	124	141	217															
10/21/93	935		8.3	1190	3.7						0.96	156	201	269															
10/28/93	1510	66	7.7	1080	2.2	6	8	5	<5	11	0.87	135	164	250		<1	143	142	54.9	27	129	4.56	<1	2	7	<5	2		
11/5/93	1055	63	7.6	1180	3.8						0.94	143	195	250															
11/12/93	1147	58	7.8	1440	4.1						0.98	184	223	198															
11/22/93	1245	56	7.5	1700	6.2						1.3	241	287	367															
11/28/93	1250	56	7.8	1930	8.0					5	1.8	241	322	428	1180	<1	175	175	94.1	47	287	5.95	<1	3	<5	<5	2		
12/3/93	1125	52	7.8	1920	6.7						1.4	274	333	373															
12/10/93	1345	56	7.8	1830	3.0						1.3	270	303	370															
12/17/93	1234		8.1	1580	6.3						1.3	217	280	332															
12/28/93	930	44	8.0	2180	7.5	6	6	7	15	<5	5	1.8	423	434	445	1400	<1	208	208	93.9	51	305	5.05	<1	3	22	<5	<1	
1/7/94	1337	48	6.8	1960	4.7						1.5	326	397	397															
1/13/94	1637	51	7.8	2610	7.5						2.2	411	464	536															
1/21/94	1250	53	8.4	2360	9.3						1.9	338	435	503															
1/27/94	1135	51	8.0	1940	7.5	7	11	11	21	7	7	1.6	281	326	393									<5	6	8	<5	6	
2/3/94	1500	50	7.6	2650	12						2.1	388	468	528															
2/11/94	1357	53	7.7	1240	6.2						1.0	161	221	257															
2/17/94	800	52	7.3	2170	13						1.9	311	458	434															
2/23/94	1212	51	7.8	1320	1.9	2	11	5	14	<5	10	1.1	200	250	282	884	<1	147	147	61	32	182	5.38	<1	8	9	<5	<5	
3/4/94	1226	62	7.7	2610	15						2.2	360	473	538															
3/9/94	1143	64	8.0	2490	16						2.1	378	516	522															
3/16/94	1155	64	7.7	2590	12						2.3	361	502	532															
3/23/94	1149	58	8.0	2750	18						2.4	393	563	573															
3/31/94	1145	66	8.0	2870	19	13	8		7	<5	13	2.5	454	626	624	1880	<1	<1	217	137	69	392	5.52	<1	2	<5	<5	14	
4/6/94	1440		8.2	2770	18						2.3	408	550	807															
4/15/94	1315	73	7.8	2960	13						2.1	501	626	580															
4/21/94	1355	73	7.9	3210	19						2.5	549	652	671															
4/27/94	1334	62	7.9	2880	16	12	6	4	6	<5	7	2.2	454	578	588	1900	<1	230	230	129	64	375	5.44	<1	5	<5	<5	<1	
5/4/94	1520	72	7.7	2980	14						1.8	458	568	590															
5/10/94	1555	80	7.9	2210	13						1.7	326	421	444															
5/16/94	1300	69	7.9	3670	28						3.2	646	857	766															
5/25/94	845	71	6.9	2550	17	19	9	6	6	<5	9	2.5	463	624	539	1720	<1	199	199	119	59	378	5.19	1	3	<5	<5	4	
6/1/94	1330	81	8.0	2540	17						2.3	430	575	538															
6/8/94	1140	66	7.9	3180	22						4.0	526	690	909															
6/15/94	1245	71	8.5	3240	25						5.0	503	754	1090															
6/21/94	1222	78	8.1	2990	27						3.3	462	706	730															
6/29/94	1110	80	7.9	2830	24	10	18	8	13	<5	16	2.9	438	619	664	2000	<1	198	198	158	66	396	6.71	2	2	<5	<5	3	
7/6/94	1220	79	7.8	2470	25						1.9	170	300	570															
7/13/94	1210	83	8.0	2700	27						2.3																		
7/21/94	1452	79	8.1	2280	18						1.7	320	520	530															
7/27/94	1135	79	8.1	2040	16	8	9	7	11	3	<10	2.1	260	420	450	1300	<1.2	190	160	110	45	270	5.00	<1	2	<5	<10	3	

San Joaquin River at Hills Ferry Road (STC512) continued:

Date	Time	Temp F	pH	EC umhos/cm	Se	Mo	Total ug/L				mg/L										Dissolved ug/L								
							Cr	Cu	Ni	Pb	Zn	B	Cl	SO4	HDNS	TDS	CO3	HCO3	TALK	Ca	Mg	Na	K	Cr	Cu	Ni	Pb	Zn	
8/3/94	1215	78	8.1	1850	14							1.8	250	410	410														
8/10/94	1325	80	8.1	2130	18							1.3	290	480	490														
8/16/94	1204	80	7.6	2240	17							2.3																	
8/24/94	1210	77	7.8	2380	17							2.4	310	520	550														
8/31/94	925	74	7.9	2200	11	9						1.9	330	600	470	1400	<1.2	200	170	100	53	280	5.00	<10	<20	<20	<50	<5	<5
9/7/94	1240	78	8.2	2070	11							1.6																	
9/14/94	1215	74	8.4	2280	10							1.5																	
9/22/94	1245	76	8.2	2540	9.4							1.4																	
9/29/94	1020	70	6.7	2590	18	11						1.9	410	490	490	1700	<1	230	190	100	56	370	4.60						
Count	49	52	52	52	52	11	10	9	9	10	10	52	46	46	46	10	11	11	11	11	11	11	11	11	11	11	11	10	10
Min	44	6.7	1030	1.2	2	2	5	4	<5	3	5	0.61	124	141	198	884	<1	143	142	54.9	27	129	4.56	<1	2	<5	<5	<1	<1
Max	83	8.5	3670	28	19	18	18	11	21	7	16	5.0	646	857	1090	2000	<1	230	230	158	69	396	6.71	2	8	22	<50	<50	14
Mean	67	7.9	2270	13	9	9	9	6	10	2	9	1.9	337	452	496	1540	<1	175	185	105	52	306	5.31	1	4	5	2	4	4
Geo Mean	66	7.8	2180	9.9	8	8	9	6	8	2	8	1.8	313	416	465	1500	<1	104	183	101	50	291	5.28	0.5	3	3	2	2	2
Median	70	7.9	2280	13	9	9	9	6	11	<5	8	1.9	328	466	497	1550	<1	198	190	100	53	305	5.19	<1	3	<5	<5	2	2

San Joaquin River at Crows Landing Road (STC 504)

Location: Latitude 37° 25' 55" Longitude 121° 00' 42". In Section 8 T.6S R8E. West Bank, 100 yards south of Crows Landing Road Bridge, 4.2 mi. northeast of Crows Landing. River mile 107.1

Date	Time	Temp °F	pH	EC µmhos/cm	Se	Mo	Cr	Cu µg/L	Ni	Pb	Zn	B	Cl mg/L	SO4	HDNS
10/2/92	1155	68	7.6	1480	0.8							0.62			
10/9/92	840	62	7.7	1600	0.8							0.67			
10/16/92	1330	69	8.3	1450	0.4							0.49			
10/23/92	1330	67	8.4	980	0.7							0.37			
10/29/92	905	64	8.6	580	0.2	2	<5	8	14	<25	7	0.20	86.1	74.1	124
11/5/92	1525	66	7.9	780	1.5							0.45			
11/13/92	1122	55	8.3	930	2.1							0.60			
11/30/92	1120	49		1020	0.6	4	5	3	<5	<5	5	0.45	173	138	200
12/4/92	1115	50	8.6	980	0.4							0.39			
12/14/92	930	46	8.1	1350	6.0							1.3			
12/22/92	1240	49	8.4	1460	4.2							2.1			
12/30/92	900	45		1480	5.0	5	3	<5	<5	<5	4	0.99	234	252	269
1/8/93	1200	56	7.9	1030	3.7							0.70			
1/15/93	1240			330	0.7							0.17			
1/22/93	1215	54	8.5	540	1.9							0.44			
1/28/93	950	48		980	3.4	3	8	7	<5	<5	10	0.77	117	157	195
2/4/93	1140	52	9.3	1610	6.1							1.3			
2/10/93	1215	55		900	3.0							0.67			
2/19/93	1300	57	8.0	920	3.6							0.65			
2/25/93	1315	56	8.0	940	3.8	3	11	14	12	29	28	0.74	111	164	209
3/5/93	1245	61	7.9	1130	4.3							0.93			
3/12/93	1350	65	7.5	1940	8.0							1.3			
3/18/93	1400	66	7.9	1780	5.4							1.0			
3/25/93	1230	60	7.6	1680	7.5	5	6	76	<5	<5	9	1.2	246	289	323
4/2/93	1405	63	7.7	1050	3.8							0.75			
4/9/93	1512	65	8.2	1040	3.9							0.73			
4/16/93	1302	62	8.1	737	3.6							0.54			
4/23/93	1215	62	8.1	790	1.4							0.43			
4/29/93	1105	66	8.1	845	4.4	2	7	3	6	<5	14	0.58	103	134	164
5/7/93	1245	70	8.6	698	3.9							0.47			
5/14/93	1245	68	8.2	680	3.8							0.51			
5/21/93	1330	72	8.0	1060	3.0							0.60			
5/26/93		69	8.0	1430	6.5	7.5						1.1	186	255	269
6/4/93	1205	69	8.3	1090	4.0							0.80			
6/11/93	1245	72	8.2	848	4.1							0.73			
6/18/93	1310	78	8.3	810	4.6							0.64			
6/24/93	820	70	6.9	1010	5.3	3	9	4	7	<5	<1	0.95	129	176	254
7/2/93	1311	81	7.6	1280	8.5							1.1			
7/9/93	730	76	7.1	1140	6.3							0.94			
7/16/93	1300	77	8.3	1200	7.5							1.0			
7/23/93	1338	81	8.0	1190	6.7							0.97			
7/29/93	832	74	6.9	810	4.4		10	6	8	<5	11	0.75	95.4	141	183
8/6/93		78	8.0	835	5.3							0.76			
8/13/93	1350	76	8.5	749	3.8		9	5	<5	<5	8	0.63	81.8	124	160
8/20/93	1055	74	7.9	688	3.4							0.57			
8/26/93	1310	78	7.5	726	4.0	2	8	5	<5	<5	7	0.63	81.4	113	168
9/3/93	1520	79	7.9	627	2.6							0.48			
9/10/93	1535	80	8.0	602	2.5							0.41			
9/17/93	1450	69	8.3	563	1.3							0.28			
9/23/93	1300	72	7.9	640	2.4	3	7	3	<5	<5	3	0.44	79.8	104	138
Count		49	45	50	50	11	12	12	12	12	12	50	13	13	13
Min		45	6.9	330	0.2	2	<5	<5	<5	<5	<1	0.17	79.8	74.1	124
Max		81	9.3	1940	8.5	7.5	11	76	14	29	28	2.1	246	289	323
Mean		65	8.0	1020	3.7	4	7	11	5	4	9	0.72	133	163	204
Geo Mean		65	8.0	960	2.8	3	6	6	3	2	6	0.65	122	152	197
Median		66	8.0	980	3.8	3	7.5	5	<5	<5	7.5	0.66	111	141	195

San Joaquin River at Crows Landing Road (STC 504)

Location: Latitude 37° 25' 55" Longitude 121° 00' 42". In Section 8 T.6S R8E. West Bank, 100 yards south of Crows Landing Road Bridge, 4.2 mi. northeast of Crows Landing. River mile 107.1

Date	Time	Temp F	pH	EC umhos/cm	Se	Mo	Cr	Cu ug/L	Ni	Pb	Zn	B	Cl mg/L	SO4	HDNS
10/1/93	1513	75	8.0	719	0.6							0.29			
10/8/93	1500	68	8.4	382	0.5							0.17			
10/15/93	1250	63	8.3	209	0.3							0.11			
10/21/93	947		8.1	517	1.0							0.44			
10/28/93	1540	66	7.7	816	2.4	4	4	3	9	<5	8	0.65	99.7	128	174
11/5/93	1105	62	7.7	851	2.3							0.55			
11/12/93	1203	58	7.9	1030	2.3							0.67			
11/22/93	1300	55	7.8	1180	3.5							0.82			
11/28/93	1311	56	7.9	1230	3.6		4	3	<5	<5	4	0.82	162	185	238
12/3/93	1145	53	7.9	1220	3.0							0.79			
12/10/93	1400	56	7.9	1310	4.2							0.99			
12/17/93	1247		8.1	1140	4.1							0.92			
12/28/93	905	44	8.4	1400	4.0	4	4	4	8	<5	<1	1.0	179	221	290
1/7/94	1355	48	7.1	1250	1.6							0.82			
1/13/94	1620	51	7.8	1580	4.1							1.3			
1/21/94	1305	54	8.7	1580	5.2							1.3			
1/27/94	1100	50	8.0	1350	4.9	5	9	10	14	<5	9	1.1	171	211	277
2/3/94	1520	50	7.7	1780	7.2							1.3			
2/11/94	1407	52	7.7	823	3.6							0.62			
2/17/94	1520	53	7.5	1490	8.1							1.2			
2/23/94	1157	52	7.7	998	3.2	1	12	9	16	<5	15	0.81	148	193	219
3/4/94	1240	63	7.7	1840	9.6							1.4			
3/9/94	1205	64	8.0	1700	9.0							1.3			
3/16/94	1210	64	7.8	1700	7.4							1.3			
3/23/94	1205	60	8.0	1840	11							1.5			
3/31/94	1115	68	8.0	1630	9.2	6	6		<5	<5	33	1.3	117	157	350
4/6/94	1456		8.2	1730	9.6							1.3			
4/15/94	1330	72	7.8	1740	6.7							1.3			
4/21/94	1420	72	7.9	1850	8.2							1.2			
4/27/94	1354	60	8.3	836	3.9	2	5	4	<5	<5	4	0.60	112	125	181
5/4/94	1340	72	7.8	1450	5.6							0.86			
5/10/94	840	67	7.5	732	5.3							0.75			
5/16/94	1315	67	7.1	1510	8.8							1.1			
5/25/94	830	71	7.2	1420	8.3	15	5	3	<5	<5	5	1.3	205	297	319
6/1/94	1350	80	8.1	1360	7.5							1.0			
6/8/94	1155	66	8.1	1780	11							1.5			
6/15/94	1300	72	8.6	1810	9.7							1.6			
6/21/94	1243	76	8.1	1980	13							1.6			
6/29/94	1230	80	8.2	1870	13	7	8	6	6	<5		1.9	255	370	490
7/6/94	1225	80	7.9	1660	11							1.1			
7/13/94	1220	80	7.9	2040	13							1.6			
7/21/94	1518	77	8.0	904	6.6							0.76			
7/27/94	1200	79	8.3	762	4.1	3	6	6	6	4	<10	0.59	89	120	150
8/3/94	1230	76	8.1	1340	6.8							1.1			
8/10/94	1345	80	8.0	1710	10							1.4			
8/16/94	1220	79	7.9	1630	7.5							1.2			
8/24/94	1230	76	7.9	1670	8.7							1.4			
8/31/94	900	72	7.4	1430	5.4	6						1.0			320
9/7/94	1300	75	8.2	1700	7.8							1.2			
9/14/94	1225	74	8.6	1780	8.5							1.2			
9/22/94	1300	76	8.2	1660	3.9							0.80			
9/29/94	950	68	7.7	1410	3.9	5						0.75			280
Count		49	52	52	52	11	10	9	10	10	9	52	10	10	12
Min		44	7.1	209	0.3	1	4	3	<5	4	<1	0.11	89	120	150
Max		80	8.7	2040	13	15	12	10	16	4	33	1.9	255	370	490
Mean		66	7.9	1370	6.2	5	6	5	6	2	9	1.0	154	201	274
Geo Mean		65	7.9	1270	4.9	4	6	5	4	1	5	0.93	146	188	260
Median		67	7.9	1440	6.1	5	6	4	6	<5	5	1.1	155	189	279

San Joaquin River at Las Palmas Launching Facility (Patterson) (STC507)

Location: Latitude 37° 29' 52" Longitude 121° 04' 54". In SW 1/4, NW 1/4, SW 1/4, Section 15 T.5S., R. 8E. West Bank, 0.3 mi N of Patterson Bridge at NE corner of Las Palmas Launching Facility parking lot, 3.2 mi. NE of Patterson. River mile 98.6.

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	B mg/L	Cl mg/L	SO4 mg/L	HDNS mg/L
10/2/92	1210	70	7.7	1320	0.7	0.46			
10/9/92	820	63	7.5	1720	0.8	0.66			
10/16/92	1345	69	8.1	1540	0.5	0.48			
10/23/92	1340	70	7.9	1380	0.6	0.51			
10/29/92	920	64	8.1	650	0.2	0.24	95.5	75.7	149
11/5/92	1505	65	7.8	845	1.1	0.42			
11/13/92	1135	56	8.0	1030	1.8	0.65			
11/30/92	1135	50		1160	0.7	0.52	180	164	243
12/4/92	1135	51	8.6	1090	0.5	0.41			
12/14/92	910	47	8.2	1310	4.5	1.1			
12/22/92	1300	49	8.1	1490	2.0	1.1			
12/30/92	840	45		1430	4.3	0.87	206	225	264
1/8/93	1215	56	7.9	1030	3.5	0.68			
1/15/93	1300			410	1.0	0.21			
1/22/93	1225	54	8.4	570	1.8	0.43			
1/28/93	1015	47		930	2.5	0.73	118	150	196
2/4/93	1120	52	9.2	1580	5.2	1.2			
2/10/93	1230	57		1240	3.9	0.87			
2/19/93	1315	56	7.9	1240	3.5	0.78			
2/25/93	1250	57	8.0	1010	3.7	0.76	125	190	253
3/5/93	1300	61	7.8	1160	3.8	0.85			
3/12/93	1410	66	7.5	1960	6.6	1.3			
3/18/93	1420	66	7.9	2000	6.4	1.1			
3/25/93	1157	61	7.6	1690	6.1	1.2	244	285	345
4/2/93	1420	64	7.7	1130	3.6	0.73			
4/9/93	1531	65	8.1	1090	3.8	0.77			
4/16/93	1321	62	8.0	790	3.5	0.52			
4/23/93	1230	64	7.9	880	1.4	0.44			
4/29/93	1045	67	8.0	914	4.2	0.58	110	158	183
5/7/93	1300	65	8.6	864	3.4	0.51			
5/14/93	1302	68	7.9	770	3.5	0.55			
5/21/93	1345	72	7.8	1120	2.3	0.55			
5/26/93		73	7.8	1350	5.6	0.90	178	243	264
6/4/93	1226	70	8.2	1160	2.0	0.59			
6/11/93	1205	73	8.0	1080	4.4	0.73			
6/18/93	1330	79	8.2	1002	4.4	0.70			
6/24/93	835	69	7.1	1110	4.6	0.81	142	189	232
7/2/93	1327	82	7.4	1410	6.7	0.91			
7/9/93	715	76	7.1	1190	6.5	0.92			
7/16/93	1315	77	8.2	1200	5.9	0.92			
7/23/93	1354	81	7.8	1420	6.6	0.97			
7/29/93	859	76	6.9	843	3.7	0.69	104	133	194
8/6/93	1230	79	7.7	927	4.9	0.71			
8/13/93	1405	78	8.1	883	3.7	0.64	98.7	148	202
8/20/93	1110	75	7.6	743	2.8	0.59			
8/26/93	1330	79	7.7	815	3.5	0.60	93.2	122	179
9/3/93	1536	79	7.8	706	2.7	0.24			
9/10/93	1600	76	7.6	704	2.5	0.46			
9/17/93	1505	69	8.1	662	1.2	0.32			
9/23/93	1325	72	7.5	821	2.1	0.47	98.2	119	190
Count		49	45	50	50	50	13	13	13
Min		45	6.9	410	0.2	0.21	93.2	75.7	149
Max		82	9.2	2000	6.7	1.30	244	285	345
Mean		66	7.9	1110	3.3	0.68	138.0	169.0	223
Geo Mean		65	7.9	1060	2.6	0.63	131.0	161.0	218
Median		66	7.9	1090	3.5	0.67	118	158	202

San Joaquin River at Las Palmas Launching Facility (Patterson) (STC507)

Location: Latitude 37° 29' 52" Longitude 121° 04' 54". In SW 1/4, NW 1/4, SW 1/4, Section 15 T.5S., R. 8E. West Bank, 0.3 mi N of Patterson Bridge at NE corner of Las Palmas Launching Facility parking lot, 3.2 mi. NE of Patterson. River mile 98.6.

Date	Time	Temp F	pH	EC umhos/cm	Se ug/L	B	Cl mg/L	SO4	HDNS
10/1/93	1508	75	7.6	782	0.6	0.30			
10/8/93	1515	69	7.9	444	0.8	0.18			
10/15/93	1305	64	8.0	249	0.2	0.11			
10/21/93	1005		8.0	513	1.1	0.36			
10/29/93	1444	65	7.6	710	0.9	0.40	83.4	87.9	159
11/5/93	1120	62	7.4	954	1.9	0.58			
11/12/93	1221	59	7.7	1090	2.2	0.66			
11/22/93	1320	55	7.8	1210	2.5	0.93			
11/30/93	1320	55	7.8	1280	3.9	0.85	167	196	256
12/3/93	1205	54	7.8	1260	2.3	0.72			
12/10/93	1415	56	7.8	1390	3.5	1.1			
12/17/93	1304		8.0	1240	4.5	0.96			
12/28/93	835	43	6.8	1380	3.6	0.97	199	225	289
1/7/94	1413	49	7.5	1290	2.7	0.90			
1/13/94	1601	51	7.7	1590	3.5	1.3			
1/21/94	1324	54	8.6	1600	5.1	1.1			
1/27/94	1035	51	8.0	1320	4.4	1.1	167	205	286
2/3/94	1540	50	7.6	1850	7.3	1.3			
2/11/94	1429	52	7.6	707	3.6	0.48			
2/17/94	1535	53	7.3	1450	6.9	1.1			
2/23/94	1138	52	7.7	968	4.7	0.75	122	175	206
3/4/94	1255	63	7.8	1820	8.9	1.4			
3/9/94	1223	66	8.0	1720	9.2	1.3			
3/16/94	1225	64	7.8	1360	5.5	0.96			
3/23/94	1222	61	8.1	1600	9.9	1.4			
3/31/94	1045	68	8.0	1630	8.3	1.2	255	307	348
4/6/94	1513		8.4	1680	9.1	1.2			
4/15/94	1345	74	8.0	1640	6.5	1.1			
4/21/94	1435	71	7.8	1620	6.7	1.0			
4/27/94	1413	61	7.9	870	3.6	0.57	113	138	178
5/10/94	820	67	7.0	870	5.1	0.58			
5/16/94	1330	67	8.0	1470	6.8	0.90			
5/25/94	810	71	6.4	1390	6.9	1.0	189	265	305
6/1/94	1410	81	8.1	1500	7.0	1.2			
6/8/94	1215	67	7.9	1690	6.1	1.2			
6/15/94	1320	72	8.5	1720	7.1	1.4			
6/21/94	1301	78	8.2	1870	9.2	1.2			
6/29/94	1200	81	8.2	1760	11	1.4	259	336	413
7/6/94	1255	80	8.1	1530	8.8	1.2			
7/13/94	1245	80	8.4	2030	14	1.8			
7/21/94	1550	79	7.9	1140	5.7	0.73			
7/27/94	1230	79	7.9	840	4.3	0.43	78	130	170
8/3/94	1240	78	8.0	1460	7.2	1.1			
8/10/94	1355	81	8.1	1650	7.5	1.2			
8/16/94	1235	81	8.0	1990	6.8	1.2			
8/24/94	1245	76	7.9	1560	7.9	1.2			
8/31/94	840	73	7.9	1310	5.1	0.86			280
9/7/94	1317	76	8.3	1450	6.0	0.82			
9/14/94	1245	76	8.5	1620	4.8	0.80			
9/22/94	1315	77	8.2	1540	3.7	0.70			
9/29/94	925	70	7.7	1250	1.4	0.48			260
Count		48	51	51	51	51	10	10	12
Min		43	6.4	249	0.2	0.11	78.0	87.9	159
Max		81	8.6	2030	14	1.8	259	336	413
Mean		66	7.9	1350	5.4	0.94	163	206	263
Geo Mean		65	7.9	1270	4.3	0.84	151	192	252
Median		67	7.9	1450	5.1	0.97	167	201	270

San Joaquin River at Grayson Road, Laird Slough (STC511)

Location: Latitude 37° 33' 43" Longitude 121° 09' 03". In NW 1/4, SE 1/4, NW 1/4, Sec. 25 T. 4S., R7E.
Laird Park, 500 ft. south of Grayson Road Bridge, 1.5 mi. east of Grayson. River mile 89.1

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	B	Cl mg/L	SO4	HDNS
10/2/92	1235	72	7.7	1350	1.2	0.51			
10/9/92	755	63	7.5	1580	1.3	0.57			
10/16/92	1405	69	8.1	1490	0.9	0.50			
10/23/92	1405	69	7.9	1450	0.9	0.50			
10/29/92	940	64	8.0	690	0.3	0.23	103	80.4	153
11/5/92	1445	66	7.6	930	1.3	0.50			
Count		6	6	6	6	6	1	1	1
Min		63	7.5	690	0.3	0.23	103	80.4	153
Max		72	8.1	1580	1.3	0.57	103	80.4	153
Mean		67	7.8	1250	1.0	0.47	103	80.4	153
Geo Mean		67	7.8	1200	0.9	0.45	103	80.4	153
Median		68	7.8	1400	1.0	0.50	103	80.4	153

San Joaquin River at Maze Blvd. (State Highway 132) (STC510)

Location: Latitude 37° 38' 31" Longitude 121° 13' 40". In SW 1/4, NW 1/4, SW 1/4, Sec. 29, T.3S., R.7E.

West Bank, 400ft. S of Maze Blvd Bridge upstream of Blewett Drain, 5.7 mi. NW of Grayson. River mile 77.2

Date	Time	Temp °F	pH	EC µmhos/cm	Se µg/L	B mg/L
10/2/92	1250	76	8.1	1220	0.7	0.48
10/9/92	730	62	7.4	1250	0.8	0.50
10/16/92	1420	69	8.2	1150	0.9	0.43
10/23/92	1420	70	8.1	930	0.5	0.31
10/29/92	1000	63	8.0	490	0.7	0.17
11/5/92	1425	64	7.6	745	1.0	0.40
11/13/92	1205	56	7.9	865	1.4	0.45
11/30/92	1220	51		930	0.5	0.34
12/4/92	1200	51	8.1	890	0.5	0.34
12/14/92	835	46	8.9	1050	3.0	0.77
12/22/92	1415	50	7.9	1200	3.0	0.92
12/30/92	805	45		1080	2.8	0.59
1/8/93	1250	56	7.9	780	2.4	0.44
1/15/93	1315			380	0.9	0.20
1/22/93	1255	55	8.5	470	1.3	0.32
1/28/93	1050	48		780	1.6	0.55
2/4/93	1055	52	9.2	1190	3.3	0.81
2/10/93	1255			610	1.8	0.37
2/19/93	1345	57	8.0	920	3.5	0.64
2/25/93	1220	57	7.8	870	3.4	0.58
3/5/93	1320	60	7.8	920	3	0.61
3/12/93	1425	67	7.3	1570	4.4	0.85
3/18/93	1505	66	8.0	1620	4.9	0.87
3/25/93	1045	59	7.4	1360	4.1	0.84
4/2/93	1458	63	7.7	890	2.9	0.58
4/9/93	1608	68	8.2	900	3.2	0.59
4/16/93	1357	62	8.0	630	2.5	0.40
4/23/93	1245	64	7.9	695	1.2	0.39
4/29/93	1010	65	8.1	508	1.4	0.28
5/7/93	1320	68	8.4	485	2	0.28
5/14/93	1345	70	7.9	680	2.2	0.36
5/21/93	1425	74	7.8	1040	3.0	0.56
5/26/93		79	7.8	1150	3.7	0.66
6/4/93	1320	70	8.1	1030	1.3	0.48
6/11/93	1240	72	7.8	626	2.8	0.42
6/18/93	1400	78	8.2	659	2.9	0.49
6/24/93	900	70	7.3	872	2.9	0.52
7/2/93	1402	82	7.4	1020	4.2	0.72
7/9/93	645	75	7.0	937	3.7	0.75
7/16/93	1345	77	8.2	1040	4.0	0.76
7/23/93	1429	83	7.9	941	3.7	0.55
7/29/93	938	76	7.1	781	2.9	0.57
8/6/93		80	7.6	798	3.1	0.54
8/13/93	1437	79	7.7	606	2.2	0.39
8/20/93	1203	76	7.3	638	2.1	0.43
8/26/93	1415	83	7.5	608	2.1	0.45
9/3/93	1610	66	7.7	390	1.4	0.19
9/10/93	1640	76	7.5	1220	1.0	0.24
9/17/93	1550	67	8.1	398	0.8	0.19
9/23/93	1405	71	7.5	550	1.1	0.27
Count		48	45	50	50	50
Min		45	7.0	380	0.5	0.17
Max		83	9.2	1620	4.9	0.92
Mean		66	7.9	867	2.3	0.50
Geo Mean		65	7.9	818	1.9	0.46
Median		67	7.9	881	2.3	0.48

San Joaquin River at Maze Blvd. (State Highway 132) (STC510)

Location: Latitude 37° 38' 31" Longitude 121° 13' 40". In SW 1/4, NW 1/4, SW 1/4, Sec. 29, T.3S., R7E.

West Bank, 400ft. S of Maze Blvd Bridge upstream of Blewett Drain, 5.7 mi. NW of Grayson. River mile 77.2

Date	Time	Temp F	pH	EC umhos/cm	Se ug/L	B	Cl mg/L	SO4	HDNS
10/1/93	1600	75	7.5	608	0.8	0.25			
10/8/93	1548	65	8.1	225	0.7	0.09			
10/15/93	1340	65	7.9	211	0.2	0.08			
10/21/93	1045		8.0	503	0.9	0.28			
10/29/93	1519	66	8.1	689	1.4	0.42	76.2	83.8	153
11/5/93	1150	62	7.4	807	1.2	0.43			
11/12/93	1239	59	7.7	926	1.3	0.48			
11/22/93	1355	56	7.8	996	2.0	0.55			
11/30/93	1455	55	7.8	902	2.1	0.53	122	120	181
12/3/93	1240	53	7.8	1010	2.0	0.51			
12/10/93	1445	56	7.9	879	1.7	0.52			
12/17/93	1337		8.1	975	2.6	0.65			
12/28/93	800	44	6.2	1020	2.2	0.68	133	135	229
1/7/94	1439	48	7.5	780	1.8	0.48			
1/13/94	1530	52	8.0	808	1.7	0.64			
1/21/94	1359	54	8.7	926	2.6	0.58			
1/27/94	938	51	8.2	957	2.6	0.67	123	124	202
2/3/94	1600	50	7.4	1350	3.7	0.88			
2/11/94	1501	53	7.6	540	1.7	0.32			
2/17/94	1440	56	7.9	1150	4.4	0.75			
2/23/94	1107	53	7.5	822	3.6	0.56	113	135	176
3/4/94	1328	64	7.7	1440	6.6	1.0			
3/9/94	1253	65	7.9	1450	7.0	0.97			
3/16/94	1300	63	7.7	1380	5.0	0.95			
3/23/94	1254	59	8.0	1360	6.8	0.91			
3/31/94	1000	66	7.1	1190	4.6	0.77	177	192	254
4/6/94	1548		8.3	1080	5.1	0.68			
4/15/94	1420	72	7.8	1040	3.5	0.69			
4/21/94	1510	71	7.9	1110	4.0	0.64			
4/27/94	1449	61	7.8	484	2.0	0.29	64.1	70.5	106
5/10/94	740	66	7.0	524	3.9	0.36			
5/16/94	1410	68	8.1	976	3.8	0.55			
5/25/94	735	70	6.3	1100	4.0	0.58	161	163	253
6/1/94	1450	80	8.1	1130	3.7	0.71			
6/8/94	1245	67	8.0	1360	4.7	0.78			
6/15/94	1360	72	8.6	1460	4.0	0.90			
6/21/94	1337	76	8.6	1430	4.4	0.81			
6/29/94	1300	80	8.1	1440	5.9	0.93	209	229	354
7/6/94	1330	79	8.1	1260	5.4	0.83			
7/13/94	1315	81	8.5	1510	6.7	0.97			
7/21/94	1623	79	8.0	974	5.1	0.61			
7/27/94	1300	79	8.0	732	3.6	0.58	81.0	110	180
8/3/94	1250	76	8.4	1100	4.7	0.74			
8/10/94	1435	80	8.2	1360	4.5	0.83			
8/16/94	1320	82	8.0	1300	4.1	0.78			
8/24/94	1310	78	7.9	1220	3.3	0.74			
8/31/94	800	70	7.7	1250	3.6	0.73			300
9/7/94	1355	78	8.4	1160	3.5	0.56			
9/14/94	1330	74	8.5	1200	2.7	0.50			
9/22/94	1345	77	8.3	1270	3.5	0.60			
9/29/94	850	69	7.7	1040	1.5	0.41			230
Count		48	51	51	51	51	10	10	12
Min		44	6.2	211	0.2	0.08	64.1	70.5	106
Max		82	8.7	1510	7.0	1.0	209	229	354
Mean		66	7.9	1030	3.4	0.62	126	136	218
Geo Mean		65	7.9	960	2.8	0.57	118	129	209
Median		66	7.9	1040	3.6	0.64	123	130	216

San Joaquin River at Airport Way (SJC501)

Location: Latitude 37° 40' 32" Longitude 121° 15' 51". In SE 1/4, SW 1/4, NW 1/4, Sec. 13, T.3S., R.6E
West Bank, south of Airport Way Bridge, 3.2 mi. NE of Vernalis River mile 72.3

Date	Time	Temp °F	pH	EC µmhos/cm	Se	Mo	Cr	Cu µg/L	Ni	Pb	Zn	B	Cl mg/L	SO4	HDNS
10/2/92	1305	70	7.8	1010	0.7							0.38			
10/9/92	710	62	6.7	1050	0.7							0.41			
10/16/92	1435	69	8.3	1110	0.9							0.35			
10/23/92	1430	69	8.0	680	0.5							0.22			
10/29/92	1015	62	8.0	470	0.2	1						0.01	57.4	50.0	105
11/5/92	1410	64	7.3	705	1.1							0.36			
11/13/92	1220	55	7.9	817	1.3							0.41			
11/30/92	1235	51		850	0.5	3						0.32	129	99.1	178
12/4/92	1210	52	8.0	830	0.6							0.29			
12/14/92	815	46	8.9	995	2.6							0.71			
12/22/92	1435	50	8.0	1120	2.8							0.83			
12/30/92	745	45		1000	2.1	2	3	<5	<5	<5	5	0.53	134	127	196
1/8/93	1305	56	7.8	770	2.6							0.45			
1/15/93	1325			360	1.1							0.19			
1/22/93	1310	54	8.3	390	1.3							0.31			
1/28/93	1110	49		710	1.4	2	7	7	<5	<5	11	0.48	76.5	98.2	157
2/4/93	1040	52	9.6	1060	2.9							0.71			
2/10/93	1305			520	1.6							0.31			
2/19/93	1400	58	8.1	990	6.1							0.67			
2/25/93	1200	57	7.9	800	2.8	2	12	<1	<5	40	<1	0.54	97	121	191
3/5/93	1330	60	7.9	870	2.7							0.58			
3/12/93	1435	66	7.3	1390	3.8							0.82			
3/18/93	1530	66	7.8	1420	4.1							0.71			
3/25/93	1015	58	7.2	1050	3.1	2	6	7	<5	<5	13	0.59	142	151	225
4/2/93	1510	65	7.7	830	2.9							0.51			
4/9/93	1625	66	8.2	850	2.4							0.54			
4/16/93	1411	62	8.0	610	2.5							0.38			
4/23/93	1300	63	7.8	640	0.6							0.29			
4/29/93	955	64	8.2	418	1.0	1	6	3	<5	<5	7	0.20	45.8	53.4	95.0
5/7/93				393	1.4							0.20			
5/14/93	1358	68	8.1	470	1.9							0.22			
5/21/93	1441	70	7.8	666	1.8							0.33			
5/26/93		75	7.8	610	1.6	2						0.33	72.6	80.7	132
6/4/93	1335	68	8.3	543	0.6							0.22			
6/11/93	1255	73	7.8	540	2.5							0.35			
6/18/93	1410	78	8.2	592	2.4							0.40			
6/24/93	920	70	7.3	790	2.3	1	12	8	11	<5	5	0.44	105	111	170
7/2/93	1418	82	7.5	888	3.2							0.53			
7/9/93	620	74	6.7	763	2.8							0.54			
7/16/93	1355	76	8.2	866	2.9							0.55			
7/23/93	1444	80	8.0	710	2.2							0.45			
7/29/93	958	76	7.3	644	2.1							0.44	71.4	82.4	154
8/6/93		80	7.5	686	2.5							0.43			
8/13/93	1449	80	7.8	564	1.9	1	18	11	15	<5	32	0.35	60.7	75.9	140
8/20/93	1220	75	7.4	563	1.6							0.37			
8/26/93	1435	81	7.6	570	2.1	1	9	5	6	<5	8	0.37	67.6	76.0	132
9/3/93	1624	76	7.7	362	1.0							0.19			
9/10/93	1655	76	7.6	384	1.4							0.22			
9/17/93	1600	67	8.1	372	0.8							0.17			
9/24/93	1410	78	7.9	485	0.9		7	3	<5	<5	4	0.24	60.3	55.5	120
Count		47	44	50	50	11	9	9	9	9	9	50	13	13	13
Min		45	6.7	360	0.2	1	3	<1	<5	<5	4	0.01	45.8	50.0	95.0
Max		82	9.6	1420	6.1	3	18	11	15	40	32	0.83	142	151	225
Mean		66	7.8	736	1.9	2	9	5	4	6	9	0.41	86.1	90.9	153
Geo Mean		65	7.8	692	1.6	2	8	3	2	2	6	0.35	81.0	86.1	149
Median		66	7.8	708	1.9	2	7	5	<5	<5	7	0.38	72.6	82.4	154

San Joaquin River at Airport Way (SJC501)

Location: Latitude 37° 40' 32" Longitude 121° 15' 51". In SE 1/4, SW 1/4, NW 1/4, Sec. 13, T.3S., R.6E
West Bank, south of Airport Way Bridge, 3.2 mi. NE of Vernalis River mile 72.3

Date	Time	Temp F	pH	EC umhos/cm	Se	Mo	Cr	Cu ug/L	Ni	Pb	Zn	B	Cl mg/L	SO4	HDNS
10/1/93	1615	75	7.5	574	1.0							0.20			
10/8/93	1600	63	7.8	222	0.7							0.09			
10/15/93	1350	66	7.9	217	0.4							0.07			
10/29/93	1533	65	7.8	589	0.9	2	4	5	7	<5	12	0.33			
11/5/93	1215	62	7.1	726	2.0							0.38			
11/12/93	1311	58	7.8	803	1.1							0.40			
11/22/93	1410	56	7.7	837	1.5							0.45			
11/30/93	1505	55	7.7	774	1.6	3	4	3	<5	<5	3	0.46	101	97.5	160
12/3/93	1255	53	7.8	864	1.6							0.43			
12/10/93	1500	56	7.9	744	2.8							0.55			
12/17/93			8.0	836	2.0							0.50			
12/28/93	740	44	5.5	878	1.7		3	<1	<5	<5	<1	0.51	112	115	187
1/7/94	1456	47	7.5	705	1.4							0.43			
1/13/94	1514	52	7.6	703	1.4							0.68			
1/21/94	1413	55	9.0	815	2.0							0.51			
1/27/94	900	50	8.5	841	2.0		14	15	17	<5	28	0.53	104	108	187
2/3/94	1625	50	7.6	1160	2.5							0.73			
2/11/94	1521	52	7.6	648	2.2							0.36			
2/17/94	1455	55	7.9	1020	3.8							0.73			
2/23/94	1052	53	7.1	764	3.1	1	16	7	14	<5	10	0.53	107	122	164
3/4/94	1342	63	7.7	1270	6.3							0.95			
3/9/94	1302	63	7.9	1040	4.9							0.68			
3/16/94	1310	61	7.7	934	3.2							0.64			
3/23/94	1310	59	8.0	941	4.1							0.64			
3/31/94	910	64	7.5	840	3.0	2	7	12	<5	<5	5	0.52	115	120	177
4/6/94	1600		8.3	879	3.4							0.60			
4/15/94	1430	72	7.8	864	2.8							0.49			
4/21/94	1525	71	7.9	914	2.8							0.52			
4/27/94	1503	60	7.7	370	1.5	1	3	4	7	<5	5	0.21	43.4	54.3	86.2
5/10/94	725	66	6.5	492	2.8							0.29			
5/16/94	1425	68	8.1	849	2.6							0.44			
5/25/94	720	64	6.6	678	2.4	2	4	4	<5	<5	5	0.33	97.5	88.6	146
6/1/94	1505	79	8.2	893	2.8							0.61			
6/8/94	1310	67	8.0	980	3.1							0.54			
6/15/94	1405	70	8.8	950	2.5							0.59			
6/21/94	1352	74	8.8	780	2.8							0.40			
6/29/94			8.4	854	3.3	2	6	6	6	<5	8	0.49	127	118	186
7/6/94	1350	79	8.2	823	3.5							0.46			
7/13/94	1330	80	8.6	950	3.8							0.47			
7/21/94	1640	77	8.1	704	3.5										
7/27/94	1320	79	7.8	611	3.1	1	15	10	14	5	31	0.46	69	89	150
8/3/94	1330	76	8.4	879	3.6							0.55			
8/10/94	1500	80	8.4	926	3.1							0.46			
8/16/94	1332	80	8.2	907	2.8							0.51			
8/24/94	1330	76	7.1	833	1.8							0.46			
8/31/94	745	69	7.3	950	2.3	2						0.49			210
9/7/94	1405	76	8.5	1000	3.0							0.48			
9/14/94	1350	76	8.6	978	2.3							0.40			
9/22/94	1400	76	8.4	977	2.1							0.50			
9/29/94	830	66	7.7	900	1.9	3						0.40			210
Count		47	50	50	50	10	10	10	10	10	10	49	9	9	11
Min		44	5.5	217	0.4	1	3	<1	<5	<5	3	0.07	43	54	86
Max		80	9.0	1270	6.3	3	16	15	17	5	31	0.95	127	122	210
Mean		65	7.8	814	2.5	2	8	7	7	2	11	0.48	97	101	169
Geo Mean		64	7.8	779	2.3	2	6	5	4	1	6	0.44	93	99	165
Median		65	7.8	845	2.6	2	5	6	7	<5	7	0.49	104	108	177

